A star (✱) indicates that the Abstract deals with Apparatus and Instruments.

JULY, 1940.

GENERAL PHYSICS.

ATOMIC AND MOLECULAR STRUCTURE.

1959. Present state of systematics of stable atomic nuclei. Part I. H. JENSEN. *Naturwiss.*, **27**, *pp*. 793–803, *Dec*. 1, 1939.—Part I of this survey deals first with the rules of Mattauch (excluding pairs of stable isobares differing by 1 in their atomic number Z), Harkins (excluding nuclei with odd Z, but even mass number), and Aston (enunciating the existence of at least 1, but not more than 2 stable isotopes of odd mass number for any Z). If atomic weight or binding energy is plotted against any 2 combinations of Z and *m* (atomic and mass number) all nuclei of odd *m* come to lie on a surface with a " valley " in which the stable nuclei are situated. The even nuclei lie on 2 similar surfaces, 1 of which, however, contains unstable nuclei only. In a 2-dimensional plot the stable odd nuclei lie on a smooth curve which forms the central line of a zone containing the stable even nuclei. The essential results of Mattauch's investigations on the width of this zone can be formulated in 3 rules : any stable nucleus of odd neutron number *n* (and, in view of Harkins' rule, automatically of even Z) is surrounded by 2 stable isotopes with $n + 1$ and $n - 1$ neutrons respectively ; for $Z > 18$ also the isotopes $n + 3$ and $n - 3$ and, finally, for $34 \leqq Z \leqq 62$ also the isotopes $n + 5$ and $n - 5$ exist. These zones cover nearly all known stable nuclei but include also a number of certainly unstable ones. If mass number and neutron excess are chosen as the independent variables of the 2-dimensional plot the unstable nuclei have, on the average, a greater vertical distance from the central curve of stable odd nuclei than the stable nuclei belonging to the same Mattauch zone. L. E. F.

1960. Binding energy of Li^7. K. G. CARROLL. *Phys. Rev.*, **57**, *pp*. 791–794, *May* 1, 1940.—A first-order Hartree calculation based upon a reasonable set of nuclear constants yields only $\frac{1}{3}$ the known binding energy of Li^7. It is of interest to know whether this discrepancy is a real failure of assumed nuclear forces or merely a result of an inadequate method of calculation. The present note reports the effect of including higher orders in the perturbation treatment. In the final result about $\frac{1}{3}$ the discrepancy remains and may be attributed to the exchange forces here assumed. [See Abstract 4736 (1938).] AUTHOR.

1961. Theory of nuclear forces. R. PEIERLS. *Nature*, **145**, *pp*. 687–690, *May* 4, 1940.—An account is given of the present state of our knowledge of the nuclear forces. R. P.

1962. Theory of meson decay. H. A. BETHE AND L. W. NORDHEIM. *Phys. Rev.*, **57**, *pp*. 998–1006, *June* 1, 1940.—A new derivation of the meson lifetime and of the β-decay formula according to Yukawa's theory is given in which the meson field equations are used in their unquantized form. The vectorial meson theory leads to a Fermi β-decay theory with the Gamow-Teller selection rules as required by experiment. It is, however, not possible to obtain a quantitative agreement for both meson decay and β-decay. When the constants are so adjusted as to give the observed lifetime for β-decay, the resulting lifetime of the meson is of the order 10^{-8} sec., as compared with about 10^{-6} sec. from cosmic-ray observations. It is shown that the uncertainties in nuclear theory do not greatly influence this result, and that most of the conceivable changes in the theory make the theoretical lifetime of the meson shorter and thus the discrepancy greater. AUTHORS.

1963. Existence of He^5 nucleus. P. JENSEN. *Zeits. f. Physik*, **115,** 1–2, *pp*. 55–60, 1940.—The author searches for protons which are produced by the hypothetical reaction $H^2(\alpha,p)$ He^5. The result is negative. None of the existing experimental and theoretical investigations offer any justification for the assumption of a stable He^5 or Li^5 nucleus. L. K.

1964. Chemical elements and natural atomic species according to results of isotopic and nuclear investigation. O. HAHN, S. FLÜGGE AND J. MATTAUCH. *Phys. Zeits.*, **41,** *pp*. 1–14, *Jan*. 1, 1940.—This paper comprises a review of the data established up to the end of 1939 concerning the numbers of isotopes of the chemical elements and their atomic weights and relative abundances. The data presented are derived from critical comparison of the results given by the various investigators. Table 1 comprises a list of the elements and their stable isotopes, the relative abundances of isotopes, their isotopic weights, packing fractions, mass defects and the calculated and international chemical atomic weights. Table 2 comprises a list of isotopes which are probably non-existent together with an indication of the maximum possible abundance with which they might occur. A packing fraction curve is also given. The main changes in the list of isotopes and weights resulting from investigations published in 1939 are discussed briefly. J. E. K.

1965. Enrichment of N^{15} by the separation column method of Clusius and Dickel. R. FLEISCHMANN. *Phys. Zeits.*, **41,** *pp*. 14–18, *Jan*. 1, 1940.—By means of the isotope separation method described by Clusius and Dickel, involving simultaneous application of thermal diffusion and convection, samples of N_2 are obtained in which the percentage of $N^{14}N^{15}$ molecules is greatly increased. With 2 diffusion tubes of 9 mm. and 11 mm. dia. and 12 m. long 770 cm³. of N_2 containing 9·2% $N^{14}N^{15}$ is obtained in 6 weeks' operation and from this sample a further sample of 110 cm³. containing 18% $N^{14}N^{15}$ is obtained in 2½ weeks. Band spectra of the samples clearly show the effect of the enrichment of $N^{14}N^{15}$.

J. E. K.

1966. Clusius' separation by thermodiffusion in liquids. J. W. HIBY AND K. WIRTZ. *Phys. Zeits.*, **41,** *pp*. 77–82, *Feb*. 15, 1940.—The theoretical treatment of thermodiffusion has been extended to an apparatus with large storage vessels and to the separation of 2 dissolved components. The Soret coefficient has been measured in solutions of Li, Na, K, Ca, Rb and Zn salts in water, with the help of the separation velocity of Clusius' method. L. K.

***1967. Thermal separation of isotopes.** W. W. WATSON. *Phys. Rev.*, **57,** *pp*. 899–902, *May* 15, 1940.—The performance of a simple multi-stage apparatus for the separation of isotopes by thermal diffusion is discussed. All parts are built of copper pipe, each unit being based on a ½-in. G.E. calrod heater of 2 m. effective heating length. Tests with a $CH_4 - N_2$ mixture show that convective coupling of the bottom of one unit with the top of the next functions well. In the case of CH_4, with 2 units preceded by a scrubber which maintains economically normal CH_4 at the "light" end, and with $\Delta T = 370$°C. between the two surfaces, the C^{13} content at the "heavy" end at equilibrium is 2·77 times the normal amount. A single unit with $\Delta T = 400°C.$ filled with Ne at $1 \cdot 5 - 1$ atm. gives a separation factor of 8 for Ne^{22}/Ne^{20}. The relative separations produced in CH_4 and Ne are shown to be in agreement with the theory. AUTHOR.

1968. Periodic properties of the system of isotopes. A. E. HAAS. *Nat. Acad. Sci., Proc.,* **26,** *pp.* 305–312, *April,* 1940.—Isotopes with even charge and mass numbers may be arranged in consecutive series, each of which is characterized by a definite value of the isotopic number (I = difference between numbers of neutrons and protons). The successive rows or periods show regular lengths if a few very weak and in some cases doubtful isotopes are disregarded. The relative abundance is usually considerably smaller in the first or last occupied column than in the others. There is also a certain periodicity with the isotopes which remain stable after addition of a proton or after addition of a neutron. Nuclei of the first kind are usually on the left-hand side of the table; those of the second kind occur mainly in the middle and sometimes towards the end. There is often some parallelism between the course of the values of the relative abundance in parts of 2 consecutive periods. Similar periodicities can also be found in 2 other tables which may be constructed by adding either a neutron or a proton to the isotopes of the first table. Another arrangement is also considered in which the isotopes are arranged in chains, the charge number increasing by 2 and the mass number by 6 in passing from one place to the next. Considering all stable nuclei there is a concentration of values of the relative abundance within a few rather narrow intervals (50·6–50·9, 26·8–27·3, 22·5–22·6, 16·5–18, 13·0–13·5, and 11·1–11·6%). A. J. M.

1969. Missing heavy nuclei. L. A. TURNER. *Phys. Rev.,* **57,** *pp.* 950–957, *June* 1, 1940.—Considerations of the regularities in the distribution of isotopes lead to the following conclusions. (1) Rn, AcA, ThA, and RaA should all be somewhat β-active but the branching ratios would be too small for detection of the activity except for Rn and RaA. (2) ${}_{93}EkaRe^{239}$ should be β-active with a roughly estimated half-life of about 1 month, ${}_{93}EkaRe^{237}$ should be an α-emitting nucleus, and ${}_{92}U^{237}$ should be β-active. (3) The heaviest β-stable isotopes of transuranic elements should be as follows: ${}_{93}EkaRe^{237}$, ${}_{94}EkaOs^{244}$, ${}_{95}EkaIr^{243}$, ${}_{96}EkaPt^{250}$. It is shown that isotopes of transuranic elements should undergo fission upon exposure to slow neutrons, which may account for their absence in nature. Their presumable greater probability for spontaneous fission might also account for their absence. The relative abundance of U^{235} and U^{238} is in fair agreement with the hypothesis that the amount of U^{235} was determined by a balance between production from U^{239} and loss by fission. The probable chain of disintegrations of $4n + 1$ nuclei is discussed. The estimated half-lives of all are too short for them to have survived. Their absence is to be attributed to the absence of a possible long-lived transuranic ancestor. Either the hypothetical irradiation by neutrons or spontaneous fission of a transuranic ancestor will account for the low abundance of Bi^{209}. AUTHOR.

1970. Structures of inorganic pentahalide molecules in the vapour phase. H. A. SKINNER AND L. E. SUTTON. *Faraday Soc., Trans.,* **36,** *pp.* 668–680, *June,* 1940.—The structures of Nb and Ta pentabromides and pentachlorides in the vapour phase have been investigated by electron diffraction. The compounds have the trigonal bipyramid structure, and the observed bond lengths are: $Nb-Br = 2 \cdot 46 \pm 0 \cdot 03$, $Nb-Cl = 2 \cdot 29 \pm$

0·03 : Ta—Br=2·45±0·03 : and Ta—Cl=2·30±0·02Å. The significance of the experimental results is discussed. AUTHORS.

1971. Structures of $BiCl_3$ and $BiBr_3$ in the vapour phase. H. A. SKINNER AND L. E. SUTTON. *Faraday Soc., Trans.*, **36,** *pp.* 681–685, *June*, 1940.—The structures of $BiBr_3$ and $BiCl_3$ have been investigated by the electron diffraction method. Both compounds have a pyramidal structure with the dimensions : (1) $BiBr_3$: Bi—Br=2·63±0·02 Å ; Br—Bi—Br=100°±4°. (2) $BiCl_3$: Bi—C=2·48±0·02 Å ; Cl—Bi—Cl=100°±6°. AUTHORS.

1972. Computation of molecular radius from molar volume and velocity of sound. W. SCHAAFFS. *Zeits. f. Physik*, **115,** 1–2, *pp.* 69–76, 1940.—The author improves the accuracy of his formula for the evaluation of the molecular radius by substituting the adiabatic velocity of sound for the isothermal value. Furthermore, the differential quotient of the van der Waals term *b* by the density is no longer neglected. L. K.

See also Abstracts 1975, 1986, 2044, 2095, 2134, 2135, 2141, 2143, 2144, 2157.

COLLOIDS.

1973. Viscosity of stannic phosphate gels during setting. M. PRASAD AND K. V. MODAK. *Indian Acad. Sci., Proc. A*, **11,** *pp.* 282–287, *April*, 1940.—Viscosities of gel-forming mixtures containing various quantities of stannic chloride and phosphoric acid have been measured during the formation of gels at constant temperature. Effects of change of temperature and of the addition of non-electrolytes on the changes in viscosities have also been examined. It has been found that the rate of increase in viscosity with time increases with (*a*) an increase in (i) the quantity of phosphoric acid and (ii) temperature and (*b*) a decrease in the quantity of (i) stannic chloride and (ii) non-electrolytes. AUTHORS.

***1974. Coefficient of thixotropy of suspensions of carbon black in mineral oil.** J. E. ARNOLD AND C. F. GOODEVE. *J. Phys. Chem.*, **44,** *pp.* 652–670, *May*, 1940.—An instrument for the measurement of anomalous viscosity is described, together with its calibration and mode of use. An analysis was made of the flow of thixotropic fluids, and it is shown that true elemental viscosities may be measured in absolute units. Suspensions of carbon black in liquid paraffin were studied, and it was found possible to mill them to give constant and reproducible results. It was found that over the range 4 to 7% carbon black, the value of the coefficient of thixotropy, θ, increases as the square of the concentration. Temperature is shown to have little effect on θ over a fairly wide range but the normal large effect on the residual viscosity. The results have been interpreted in terms of the " impulse theory " of thixotropy. AUTHORS.

1975. Physical investigations of albumen molecules. P. JORDAN. *Naturwiss.*, **28,** *pp.* 69–77, *Feb.* 2, 1940.—An account of an examination by modern physical methods of the molecular structure of white of egg as an example of protein. The methods of investigation were : (1) determination of molecular weight ; (2) X-ray examination as in the Patterson-Harker analysis of insulin ; (3) molecular network methods ; (4) denaturization by heat ; (5) denaturization by radiation. J. J. S.

1976. Disperse structure of solid crystal systems. D. BALAREW. *Kolloid Beihefte*, **51,** 5–7, *pp.* 123–140, 1939.—From the author's theory of real crystal systems it appears that between the typical gel—whose particles have crystal structure—and, for instance, rock-salt crystals, there exists no qualitative difference in principle, but only a gradual quantitative change. J. J. S.

See also Abstracts 2190, 2273.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

1977. Consistent notation for point positions in space groups. L. W. McKeehan. *J. Chem. Phys.*, **8,** *p.* 346, *April*, 1940.—The notation proposed avoids the use of fractions, and signs of + and −, and expresses the co-ordinates of the various points by exactly 2 typed characters, e.g. in place of ($\frac{1}{8}$, x, $\frac{1}{4} - x$) the proposed notation is ($160u3\bar{u}$). C. A. S.

1978. Theory of vibrations of NaCl lattice. E. W. Kellermann. *Roy. Soc., Phil. Trans. A*, **238,** *pp.* 513–548, *May* 24, 1940.—According to Born's treatment of polar crystals, the frequency equation for a vibrating crystal contains in its coefficients lattice sums which are due to long-range Coulomb forces. Using a method developed by Ewald it has been possible to find a quickly convergent form of those sums. The general formulae for the coefficients have been developed and a special application has been made to the case of NaCl. The coefficients and also the frequencies themselves have been calculated for 48 different states of vibration of the crystal which are chosen in such a way as to make possible a fair survey over the whole frequency spectrum of the crystal. It appears that the purely electrostatic derivation of the general formulae for the coefficients does not give information about the case of the residual rays. This can only be obtained by taking account of the electrodynamic boundary conditions, namely that the crystal as a whole must not emit radiation, which leads to the correct solution for the frequency of the residual rays. The formulae for the coefficients have also been used for the calculation of the elastic constants of NaCl. Author.

1979. The structure of Ag-Sb alloys. F. Weibke and I. Efinger. *Zeits. f. Elektrochem.*, **46,** *pp.* 53–60, *Feb.*, 1940.—Alloys of Sb and Ag were investigated throughout the range of 17% to 31% Sb by means of thermal, microscopic and X-ray methods, and the existence of 2 intermediate phases at room temperature was established. The ϵ-phase shows an hexagonal close packing of atoms: its composition and lattice dimensions vary somewhat with temperature. The rhombic phase of composition Ag_3Sb exists in 2 modifications, which give practically indistinguishable X-ray photographs. A phase-rule diagram of the various alloys and their regions of existence is given, as well as data concerning the lattice dimensions of some of these alloys. G. G.

1980. Investigation of changes of state in metals by the retrogressive process. H. Auer and H. Schröder. *Ann. d. Physik*, **37,** 2, *pp.* 137–154, *Jan.*, 1940.—The retrogressive process consists in a step-wise heat treatment of e.g. an alloy of Al and 5% Cu till the initial value of the magnetic susceptibility (before the change of state had set in) is reached [see Abstract 4164 (1939)]. Other physical properties, such as the specific heat, the electrical resistance, etc., can be used instead of the magnetic susceptibility. The conditions under which the retrogressive process can be carried out are investigated. Under the heat treatment pre-states are formed which are caused by the increase of one kind of atom in the lattice of the supersaturated mixed crystals. A quantitative analysis of the formation and destruction of pre-states under certain processes of annealing allows conclusions to be drawn on the energetic structure of the interatomic forces in the pre-states. L. K.

1981. X-ray study of aragonite in natural and cultured pearls. A. E. Alexander. *Am. J. Sci.*, **238**, *pp.* 366–371, *May*, 1940.—The X-ray diffraction method for differentiating pearls has been applied to several specimens which were subsequently examined in thin sections under high magnification. The data obtained by these two procedures have been correlated. Powder photograms of natural crystalline aragonite and pearl aragonite reveal that the 2 forms of orthorhombic calcium carbonate are fundamentally identical in structure. Author.

1982. Isomerism of Schiff bases, benzylidene-benzhydrylamine and benzhydrylidene-benzylamine. R. Candel-Vila and R. Cantarel. *Comptes Rendus*, **210**, *pp.* 628–630, *April* 29, 1940.—Benzylidene-benzhydrylamine Ph·CH:N·CHPh$_2$, is monoclinic with $a{:}b{:}c = 1\cdot9466{:}1{:}2\cdot3545$, $\beta = 108° 33'$, while the isomeric benzhydrylidene-benzylamine, Ph·CH$_2$·N:CPh$_2$ is triclinic with $a{:}b{:}c = 0\cdot76802{:}1{:}0\cdot94398$, $\alpha = 95° 47'$, $\beta = 96° 46'$, $\gamma = 84° 50'$. C. A. S.

1983. X-ray studies of porphins. I. Woodward. *Chem. Soc., J.*, *pp.* 601–603, *May*, 1940.—A preliminary X-ray examination of tetrabenzporphin and tetrabenz monazaporphin shows that, although belonging to the same space group $C_{2h}^5(P2_1/a)$ as the phthalocyanines, they differ considerably from the latter in the cell dimensions. The *b*-axis has increased from 4·7 to 6·6 Å, the *a*- and *c*-axes being diminished so that the volume of the unit cell is little altered, and the β-angle is practically unchanged. Considerable alterations in the intensities of the reflections are also observed. These changes cannot be accounted for without assuming a considerable change in the packing of the molecules. Author.

1984. Investigations of high polymers with the universal electron microscope. Part I. M. v. Ardenne and D. Beischer. *Zeits. f. phys. Chem. B*, **45**, 6, *pp.* 465–473, 1940.—The structural changes which occur in β-polyoxymethylene crystals under the influence of pressure and under the influence of bases have been investigated with the universal electron microscope. The magnification of 75 000 to 100 000 permits the observer to distinguish bundles of fibre molecules of 50 to 100 Å diameter. [See Abstract 2606 (1938).] L. K.

1985. Persistence of fine structure of bodies growing on NaCl surfaces. K. Spangenberg and G. Nitschmann. *Zeits. f. Krist.*, **102**, 4, *pp.* 285–344, 1940.—An elaborate series of observations was made, by means of a goniometer and applications of photography, on the accretion of substances on NaCl and over-saturation. The morphological development of the surfaces of these bodies was studied especially in the case of type I with higher over-saturation. J. J. S.

1986. Linear rate of transformation of monoclinic into rhombic sulphur. P. G. Elias, N. H. Hartshorne and J. E. D. James. *Chem. Soc., J.*, *pp.* 588–595, *May*, 1940.—The linear rate of advance of the interface between β- and α-sulphur has been measured at 20°, 30° and 40°, on polycrystalline films prepared under controlled conditions and containing a large proportion of the β-crystals with their $b(010)$ faces in the plane of the film and their direction of elongation (*c*-axis) approximately at 90° to the film edge. The rate is constant at constant temperature in contrast to the behaviour of films of *o*-nitroaniline and mercuric iodide [see Abstract 4765 (1938)], not only in the case of a straight interface started by inoculation of the film edge but also in the case of nuclei growing in all directions in the plane of the film. The rate increases with the thickness of the film over the range of thicknesses studied (0·03–0·15 mm.). The apparent activation energy is 15 000 cal. to the nearest thousand calories, which is considerably less than the internal latent heats of sublimation of the 2 forms, which are 23 500 (α-) and 22 500 (β-) cal. AUTHORS.

1987. Properties of Rochelle salt. H. MUELLER. *Phys. Rev.*, **57**, *pp.* 829–839, *May* 1, 1940.—In a qualitative way the anomalous properties of Rochelle salt can be explained on the basis of 4 different theories: (*a*) on the dipole theory, (*b*) by assuming polymorphic transitions at the Curie points, (*c*) by postulating an anomalous piezo-electric effect, and (*d*) with an interaction theory which assumes that the structure and the fundamental properties of the crystal have no unusual characteristics and which ascribes the observed anomalies to an accidental degeneration of the piezo-electric interaction between the elastic deformation and the electric polarization. The existence of a polymorphic transition at the upper Curie point is demonstrated in a new experiment and it is shown that this transition is a spontaneous elastic deformation. It can be explained on the basis of either one of the 4 theories. A quantitative analysis of the experimental data, which leads to a new interpretation of the elastic and piezo-electric measurements, shows that the theories (*b*) and (*c*) are not valid for Rochelle salt. The experimental data verify the conclusions of the dipole theory in so far as they lead to the result that Rochelle salt would show an abnormal temperature dependence of the dielectric constant even if the crystal were not piezo-electric or if the piezo-electric deformations could be suppressed. However, it is doubtful whether the clamped crystal has a Curie point. The observed Curie points of the free crystal result from the lattice-dipole coupling as described by the interaction theory. AUTHOR.

1988. Glide elements of body-centred cubic crystals, with special reference to effect of temperature. E. N. DA C. ANDRADE AND Y. S. CHOW. *Roy. Soc., Proc. A*, **175**, *pp.* 290–315, *June* 12, 1940.—The glide elements of single crystals of the body-centred cubic Na have been determined at various temperatures. The glide direction is in all cases [111], but the glide plane changes successively from (112) to (110) to (123) as the temperature goes from −185 to 20°C. It is shown that this change of glide plane with temperature is a particular case of a general rule to which body-centred metals conform: all 3 planes are possible glide planes but which is operative at any particular temperature is determined by the temperature, referred to the melting-point of the particular metal as standard. The case of iron, for which all 3 planes seem to be operative at once, is considered separately. The critical shear stress has been determined for Na and shows a small variation only over the temperature range − 185 to 20°C. Experiments with Na, Fe and Mo, go to show that the spacing of the glide planes increases markedly as the temperature is raised. It has been found that, for equal strain, the crystallite rotations, as evidenced by the asterisms, are much greater at low temperatures, where the hardening is greater, which goes to support the view that hardening is intimately connected with the rotation of crystal fragments. The breaking up of the asterisms into discrete spots which has been found with Na and K is shown to be due to recrystallization. The general implications of the results are discussed. [See Abstracts 5190, 5192 (1937).] AUTHORS.

See also Abstracts 1976, 2123, 2150, 2179, 2248, and

1150B. **Structure of alloys.** A. J. Bradley, W. L. Bragg and C. Sykes.

DENSITY.

1989. Molal volumes of solutes. O. Redlich. *J. Phys. Chem.*, **44**, *pp.* 619–629, *May*, 1940.—The difference between Masson's empirical rule and the square-root relation between molal volumes and concentration derived from the theory of Debye and Hückel is stressed. The latter is verified by means of the available data for aqueous and non-aqueous solutions. The value $k = 1{\cdot}86 \pm 0{\cdot}02$ is derived for aqueous solutions at 25°C. The molal volumes of non-electrolytes in dilute solutions depend linearly on the first power of the concentration. The theoretical formula should be used as a limiting law only and with a common coefficient varying only with the temperature and the solvent. A formula for interpolating and extrapolating molal volumes is indicated. Below a certain limiting concentration densities are determined by means of extrapolation better than by direct measurement. [See Abstract 663 (1932).] Author.

See also Abstracts 2042, 2177.

DIFFUSION AND OSMOSIS.

1990. Diffusion of Hg in Pb and Zn in Al. S. Hertzrücken, M. Butsyk and Z. Golubenko. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp.* 55–65, 1939. *In Ukrainian.*—Coefficients of diffusion of Hg in Pb and Zn in Al were determined at various temperatures by the method of evaporation under vacuum. For Hg in Pb the diffusion increased with increasing Hg content. The heats of diffusion were deduced to be 12 000 cal./mol. for 10% Hg and 46 000 cal./mol. for 13% Zn. D. S.

1991. Diffusion of the H$_2$ into a Cu-Ni alloy. S. Hertzrücken and Z. Golubenko. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp.* 67–71, 1939. *In Ukrainian.*—Annealing of a Cu-Ni alloy (25% Ni) in a stream of H$_2$ slightly reduces the lattice parameter in a time which is the shorter the higher the H$_2$ temperature. This is interpreted as due to diffusion of H$_2$ into the alloy and the heat of diffusion is found as 35 000 cal./mol. D. S.

1992. Diffusion of Zn into α-brass. S. Hertzrücken, I. Sakharov and L. Stolper. *Mém. Phys. Ukrainian S.S.R.*, **8**, 2, *pp.* 135–142, 1940. *In Ukrainian.*—The diffusion of Zn into α-brass between 600°C. and 750°C. was measured by the method of evaporation under vacuum. The diffusion heat was found to be 35 500 cal./mol. D. S.

1993. Diffusion in mixture of powders. S. Hertzrücken and M. Feingold. *Mém. Phys. Ukrainian S.S.R.*, **8**, 2, *pp.* 127–134, 1940. *In Ukrainian.*—A calculation is given of the coefficient of diffusion of one powder into another on the assumption of cubical grains symmetrically arranged. D. S.

1994. Variation of differential diffusion constant of H$_2$SO$_4$ with temperature. E. A. Hollingshead and A. R. Gordon. *J. Chem. Phys.*, **8**, *pp.* 423–424, *May*, 1940.—The differential diffusion constant of H$_2$SO$_4$ has been determined for concentrations from 0·025 to 1 mole/l. at temperatures from 10°C. to 35°C. Over the whole range of temperature the variation of the diffusion constant with concentration is similar to that previously found at 25°. The mean activation energies of transport for the temperature intervals 10–15°, 15–25° and 25–35°, are 4·9, 4·5 and 3·8 kcal., respectively. [See Abstract 4448 (1939).] Authors.

1995. Permeability of building papers to water vapour. J. D. Babbitt. *Canad. J. of Research, A*, **18**, *pp.* 90–97, *May*, 1940.—Some measurements on the permeability of various types of building papers to water vapour are reported, with a short discussion of the efficiency of the various papers as vapour barriers. [See Abstract 1898 (1939).] AUTHOR.

See also Abstracts 1965, 1966, 1967.

ELASTICITY AND PLASTICITY.

1996. Relaxation methods applied to engineering problems. Part V. Conformal transformation of a region in plane space. R. W. G. GANDY AND R. V. SOUTHWELL. *Roy. Soc., Phil. Trans. A*, **238,** *pp.* 453–475, *Feb.* 29, 1940.—Part III of this series [see Abstract 4776 (1938)] dealt (*inter alia*) with the application of relaxation methods to problems in plane-potential theory. In this paper the problem of conformal transformation is discussed as a particular example. Orthodox mathematics presents the transformation in an equation of the type $\alpha + i\beta = f(x + iy)$, which expresses a one-to-one relation between points in the original and in the transformed region; but the equation is of no concern to the practical computer provided that he can construct " maps " of which it is the mathematical expression, and for this it is only necessary to have α and β evaluated at nodal points at some regular " net". Thus the problem from a practical standpoint is to construct the α-β contours. In this paper 4 cases of common occurrence are treated, and the " α-β maps " are reproduced. The accuracy of the calculations is in general greater than a drawing can exhibit. Some incidental problems call for notice which were not confronted in Part III. Thus, whereas 1 of the 2 conjugate functions α, β can be computed by the methods given previously, its computed values (being only an approximation to a plane-harmonic function) are not in general compatible with a single-valued conjugate. In case (*c*) we are concerned with a region of infinite extent, and the device of " geometrical inversion " must be applied in order to render the problem tractable by relaxation methods. For some applications we require values of the ratio $h = |d(\alpha + i\beta)/d(x + iy)|$ at least as accurate as those of α or β: examples are given to show that the requisite accuracy is attainable, use being made (when necessary) of the fact that log h is plane-harmonic. The last problem treated (calculation of the electric capacity of a straight cable or condenser) is in essence an example of conformal transformation but can be solved when only one of α, β has been computed. It does not demand construction of the α-β map. [See following Abstract.] AUTHORS.

1997. Relaxation methods applied to engineering problems. Part VI. Natural frequencies of systems having restricted freedom. A. PELLEW AND R. V. SOUTHWELL. *Roy. Soc., Proc. A*, **175,** *pp.* 262–290, *June* 12, 1940.—In this paper relaxation methods [see preceding Abstract] are applied to the difficult problem of determining the natural modes and frequencies of a system having restricted but considerable freedom (i.e. where the independent co-ordinates number 6 or more). A theorem published recently [see Abstract 976 (1940)] is used to impose lower limits on the wanted frequency, and upper limits are calculated on the basis of "Rayleigh's principle". In the "liquidation" process these upper and lower limits converge steadily, and when they have become closely coincident both the frequency and the associated mode (which Rayleigh's principle does not determine) are given with sufficient accuracy for all practical purposes. An example treated in detail relates to undamped torsional vibrations or (by analogy) to transverse vibrations of a tensioned and loaded string. Concluding sections indicate some immediate extensions of the method, viz. (*a*) to vibrating systems which are entirely unconstrained, (*b*) to dissipative systems in which the damping forces (as is usual in practice) are relatively small, (*c*) to continuous systems, for which the method is an alternative to that given in Part IV of this series. [See Abstract 934 (1939).] AUTHORS.

1998. Physics of stressed solids. R. W. GORANSON. *J. Chem. Phys.*, **8,** *pp.* 323–334, *April,* 1940.—The theory presented is that the phenomena of deformation, flow or creep, rupture, cold working, elastic after-working, shear and other anomalous phenomena, may be interpreted and correlated from a study of the internal energy stored up in the lattice as a result of deformation. The theory, which in some aspects is corroborated experimentally, is developed by subdividing the internal energy of a system into a work or potential function and a thermal or kinetic function, and examining these functions for variations of temperature, stress, and pressure. The mechanism evolved consists of an elastic deformation which is a function of the strain or potential energy of the system, and a deformation by means of a 2-phase transfer mechanism which is a function of the thermodynamic potential relations of the system. When both processes are operative failure occurs by shear. Expressions are derived for creep or plastic flow of polycrystalline substances and for the " brittle" potential type of rupture under combined thrust and hydrostatic pressure. N. M. B.

1999. Buckling of elastic plates of variable thickness. R. G. OLSSON AND E. REISSNER. *J. Math. Phys.*, **19,** *pp.* 131–139, *April,* 1940.—A mathematical solution, in terms of confluent hypergeometric functions, of the stability conditions of a rectangular plate uniformly stressed in its plane and freely supported along the edges, the stiffness of the plate varying linearly in a direction parallel to one pair of edges. S. A. S.

2000. Elastic reactions of a slab subjected to cylindrical forces. P. DESPUJOLS. *Comptes Rendus,* **210,** *pp.* 659–661, *May* 6, 1940.—In continuation of previous work [see Abstract 1374 (1940)] the author discusses the strains characterizing the static equilibrium of a slab subjected to normal and tangential forces. J. S. G. T.

2001. Stresses in a ring supported on frictionless radial pins. A. J. S. PIPPARD. *Phil. Mag.*, **29,** *pp.* 541–547, *June,* 1940.

2002. Elastic moduli of ferromagnetic materials. Part IV. ΔE-effect of iron single crystals at high temperature. Part V. ΔE-effect of iron single crystals at high temperature and the ΔK-effect. R. KIMURA. *Phys. Math. Soc., Japan, Proc.*, **22,** *pp.* 219–251, *March,* 1940.—By repeating the measurements of ΔE-effect in iron single crystals at high temperatures, the influence of temperature on this effect is studied. $S_{H=o}$ in the directions of the principal axes ($S_{H=o}$ is $1/E$ of the magnetic origin at $H = O$) are measured at various temperatures as described in Part III [see Abstract 1376 (1940)]. $S_{H=o,}$ (100) increases with rise of temperature and after reaching a maximum at about 640°C. it decreases steeply to zero at the Curie point while $S_{H=o,}$ (111), decreases monotonely. The ratio $\{(1/K_1^2)\, S_{H=o,}(100)\}/\{(1/K_2^2)\, S_{H=o,}(111)\}$ however, decreases with the rise of temperature. K_1 and K_2 are the magnetostriction constants. At high temperature the undulatory nature of the S_H/H curves of crystals in certain orientations vanishes and they have the same form in all orientations. By plotting S_H against I, it can be seen that in the orientations far from the (100)-direction S_H becomes very small before saturation is reached. It is assumed that the magnetization of an elementary domain may point to a direction slightly inclined to the direction which makes the thermodynamical potential ϵm a minimum. By studying the distribution of the directions of the magnetic moments of the elementary domains concentrated around a direction of minimum ϵm, the effects of external forces on this distribution are discussed and S_{H-0} is evaluated. The values of S_{H-0} in the directions of the principal axes of a crystal can be evaluated from the ratio $S_{H-0,}(100)/S_{H-0,}(111)$. The agreement of this result with experiment is quite satisfactory. The effect of temperature upon the form of the S_H/H curves in the principal directions is studied. The S_H/H curves in the directions of (110) and (111) are modified under the assumption proposed in Part IV, viz. the magnetic moments of the elementary domains are distributed around one of the directions of minimum ϵm, the thermodynamical potential of an elementary domain. It is found by numerical calculation that S_H obtained is always positive and continuous (differing from the results obtained in Part III) and the calculated S_H/H curves agree with experimental results. The change in the rigidity modulus with magnetization (the ΔK-effect) is discussed. It is found that $T_{H-0} = (1/K_{H-0} - 1/K_{H-\infty})$ is a linear function of $\Gamma 3 = 3\ (\beta_2^2\ \beta_3^2 + \beta_3^2\ \beta_1^2 + \beta_1^2\ \beta_2^2)$, where K is the rigidity modulus and $(\beta_1, \beta_2, \beta_3)$ the orientation of a crystal, and it is also proved that T_{H-0} can be expressed in terms of S_{H-0}. **Errata,** *ibid., pp.* 327–328, *April*, 1940. S. A. S.

***2003. Automatic maintenance of load in creep testing.** G. A. MELLOR AND E. A. JENKINSON. *Journ. Sci. Instruments*, **17,** *pp.* 155–156, *June*, 1940.—A test piece is suspended from a steel frame and loaded through a lever arm which falls as the specimen elongates and is restored automatically to the horizontal by means of the apparatus described. As the lever arm falls an electrical contact is made, permitting the passage of a current through solenoids mounted on a reciprocating shaft at the top of the frame. A pawl, also mounted on the shaft, is brought into operation by the solenoid and turns a ratchet wheel. The upper tension bar of the testing unit screws into a wheel which is connected by gearing to the ratchet wheel so that movement of the latter by the pawl raises the test piece and lever arm. AUTHORS.

See also Abstracts 1978 and
1208B. Stress measurement by magnetostriction. F. D. Smith and C. A. Luxford.

HYDRODYNAMICS AND AERODYNAMICS.

2004. Theory of plane perturbations in frictionless gases. K. BECHERT. *Ann. d. Physik*, **37,** 2, *pp.* 89–123, *Jan.*, 1940.—The theory of plane perturbations in frictionless gases is developed. It is shown that the problem can be reduced to Darboux's differential equation. The integration of the equation is carried out for $n = 3/1, 5/3, 7/5$, where $n = c_p/c_v$. As examples are given: density fluctuations in a stationary gas, reflection of a density perturbation from a rigid wall, stationary waves between rigid walls for $n = 3$ and $(2m + 3)/(2m + 1)$. L. K.

2005. Adimensional motion of a vortex and its application to the trochoidal waves of Gerstner. T. LEVI-CIVITA. *Pont. Acad. Sci., Acta*, **4,** 4, *pp.* 23–30, 1940.—The classical idea of a vortex according to Helmholtz is derived from the field of velocity of a fluid in motion. If, in the space occupied by the fluid at a given moment t, the particle, which finds itself at that instant in the position P and having the velocity $v(\mathrm{P}, t)$, is defined as a vortex (in P at the instant t), the vector $\omega(\mathrm{P}, t)$ is deduced from v by means of the rotor differential operator, $\omega(P, t) = \frac{1}{2} \operatorname{rot} v\,(P, t)$. If the vector v (during a certain interval of time) is derived from a potential, ω is zero (in that interval) and the motion is called irrotational. ω is not a pure number but actually a physical quantity of dimension t^{-1} whose numerical value, when not rigorously zero, depends on the choice of the unit of time. The author applies these notions to the waves of Gerstner and certain special cases of wave motion. J. J. S.

2006. Application of the hodograph method to the flow of a compressible fluid past a circular cylinder. K. TAMADA. *Phys. Math. Soc., Japan., Proc.*, **22**, *pp*. 208–219, *March*, 1940.—Investigates the flow of a compressible fluid past a circular cylinder by means of the hodograph method. It is assumed the fluid obeys an approximately adiabatic law, the equation for which is given in the paper. Starting from the well-known solution for the incompressible fluid flow past a circular cylinder the compressible fluid flow past a nearly circular cylinder is calculated. Since it is very interesting to know the quantitative difference between the nearly circular profile and the original true circular profile, the deformed profile is calculated when the Mach number $M = 0 \cdot 4$. It is thus found that the deformed profile is very similar to the original circular profile, but the radius of the former is somewhat smaller than that of the latter. The calculated results are compared with those calculated by using the second approximate solution and also with the experimental results of Taylor. The result of comparison shows that the hodograph method can be successfully applied to the case of compressible fluid flow past a circular cylinder. S. A. S.

2007. Hydrodynamic resistance at reduced pressures. A. PAVLENKO. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp*. 73–81, 1939. *In Ukrainian*.—Coefficients of hydrodynamic resistance of air currents were measured from 100 mm. to 1 atm. pressure. The data at 1 atm. agree with Blasius' law, while those with Reynolds number below 3 500 at lower pressures satisfy Poiseuille's law. For Reynolds number above 3 500 the resistance is between the values for laminar and turbulent flow. D. S.

2008. Flow of compressed gas in a smooth cylinder. B. DEUTCHMANN AND A. POLONSKY. *Mém. Phys. Ukrainian S.S.R.*, **8**, 2, *pp*. 175–192, 1940. *In Ukrainian*.—Results are presented and discussed of experiments on velocity profiles and hydrodynamic resistance in air streams of velocity up to $\frac{9}{10}$ that of sound in a smooth cylindrical tube. The Reynolds number ranged from $3 \cdot 9 \times 10^5$ to 5×10^5 in the experiments. D. S.

2009. Spontaneous breaking-up of liquid jet. G. LITTAYE. *Comptes Rendus*, **210**, *pp*. 600–602, *April* 22, 1940.—The theory of Rayleigh, which gives that a cylinder of liquid of diameter d will be unstable or stable if its length is greater or less, respectively, than πd has been verified experimentally with a jet of water issuing from a capillary tube. Although results were variable, they agreed with the theory. The jet was horizontal and the water issued with considerable velocity. The ratio of the diameters of the jet and the capillary varied from $0 \cdot 87$–$0 \cdot 89$. [See Abstract 3133 (1939).] A. J. M.

***2010. Doppler effect on water waves.** Z. GYULAI. *Phys. Zeits.*, **41**, *pp*. 26–27, *Jan*. 1, 1940.—Two lecture-room experiments are described for demonstration of the Doppler effect on capillary waves on water. In one case an electrically vibrated needle produces circular waves in a stream of running water the wavelength of which can clearly be seen to be shorter in the direction opposite to the direction of flow of water than in the direction of flow. In the second experiment a glass rod inserted in a vertically descending water jet acts as the source of the capillary waves which are seen to be shorter above than below the rod. In both cases the effects can be projected on to a screen. J. E. K.

***2011. Modified capacitance bridge for airscrew tests.** C. D. Smith. *Journ. Sci. Instruments*, **17**, *pp*. 157–160, *June*, 1940.—The use of the Maxwell capacitance bridge for the measurement of rotational speeds has been developed for wind tunnel tests on airscrews. Airscrew performance depends on the wind speed V as well as the rotational speed n, being expressible as a function of the ratio of these two quantities. The deviation of the actual tunnel speed from its nominal value is determined by the prevailing atmospheric temperature and pressure, and its effect on the ratio V/n is arranged to be compensated for by means of additional resistances introduced into one of the ratio arms of the bridge and calibrated directly in degrees centigrade and inches of mercury. At high rotational speeds the charging of the condenser during each cycle may not be complete, but this difficulty is overcome by connecting a large capacitance across the leads to the commutator. Author.

See also Abstracts 2266 and
1138B. Flow of water in open canals of curved trajectory. F. Ramponi.

KINETIC THEORY OF MATTER

2012. Velocity distribution of gaseous molecules. Table for obtaining values of error function complement. A. H. Heatley. *Canad. J. of Research, B*, **18**, *pp*. 123–127, *May*, 1940.—The formula for the computation of the fraction of the molecules in a gas that possess energy above a specified amount is simple when motion in only 2 directions is considered but becomes difficult to evaluate when 3 directions are considered. The ratio of the results for the 2 cases may be easily computed by means of the function $L(x)$, a table of which is given. The relations of $L(x)$ to the error function complement $Erfc(x)$, to the error function $Erf(x)$, and to the Miller and Gordon function $F(x)$, are shown. An extension of the table of $F(x)$ is also given. Author.

See also Abstracts 2232, 2233.

MASS.

***2013. Pendulum analysis in scale industry.** G. R. Carley. *J. of Applied Physics*, **11**, *pp*. 314–324, *May*, 1940.—Forces created when loads are applied to the platforms of automatic weighing mechanisms are frequently balanced by the rotation of pendulums. In certain types of pendulum-controlled scales it is desired that the relationship between the load applied and the angle turned by the pendulums be essentially linear. Even though the cams used for pendulum rotation are sectors of circles, it has been found experimentally that, by the proper adjustment of various pendulum parameters, linear performance can be approximated to within less than 0·025% of scale capacity. An analysis of the forces involved in such systems leads to a mathematical statement of pendulum performance. Furthermore, experimental results confirm quantitatively the operation predicted by analysis. A method of selecting parameters for optimum performance is presented. Author.

MATHEMATICAL METHODS AND THEORY OF MEASUREMENTS.

2014. Analytical determination of homographic parameters in nomograms of aligned points. A. Eigermann. *Rev. sci., Paris.*, **78,** *pp.* 139–145, *March,* 1940.—In general, the anamorphosis of a relation between 3 variables, in view of the construction of a nomogram of aligned points, should be followed by a suitable homographic transformation, whose object is to give to the abac obtained the best disposition for its practical utilization. The homographic treatment of a nomogram gives, in general, 4 arbitrary parameters and the object of the present paper is to determine these parameters, simply and directly, in cases most frequently met with in practice. The general account of the analytical method employed is illustrated by practical examples. A. W.

2015. Analysis of asymmetrical experiments. P. V. K. Iyer. *Indian Acad. Sci., Proc., A,* **11,** *pp.* 369–375, *April,* 1940.—The application of the principle of least squares to the analysis of asymmetrical experiments (simple as well as complex) is explained with special reference to the partition of the treatment sum of squares. Author.

2016. Formulation of an experimental law. P. Vernotte. *Comptes Rendus.* **210,** *pp.* 565–567, *April* 15, 1940.—The author farther develops the method [see Abstract 1720 (1940)] for the tracing of an experimental curve and its formulation, which involves the employment of a function with 5 parameters. The remarkable characteristic of this function of permitting, in spite of its complexity, the calculation of the parameters by a system of linear equations may be generalized. J. J. S.

2017. Heaviside's expansion theorem. F. H. Miller. *J. of Applied Physics,* **11,** *pp.* 343–346, *May,* 1940.—Heaviside's differential operator, p, is defined and its significance briefly discussed; a formal treatment of the operational calculus, more especially relating to the expansion theorem (given in 2 forms), complex zeros of $F(z)$ and trigonometric operands, is presented with a view to giving the calculus greater practicability. J. S. G. T.

2018. Periodic Lamé Functions. E. L. Ince. *Roy. Soc. Edinburgh, Proc.,* **60,** 1. *pp.* 47–63, *and* 83–99, 1939–1940.

2019. Estimation of factor loadings by method of maximum likelihood. D. N. Lawley. *Roy. Soc. Edinburgh, Proc.,* **60,** 1, 64–82, 1939–1940.—The method of maximum likelihood is used to estimate the loadings of a battery of tests in the factors which are assumed to be present. In a simple numerical example the results obtained are compared with those found by using various other methods. A method, suitable for large samples, is then given for testing the truth of any hypothesis made concerning the number of factors required. Author.

2020. Time distribution of so-called random events. W. Feller. *Phys. Rev.,* **57,** *pp.* 906–908, *May* 15, 1940.—This paper contains a discussion and complete solution of a problem treated recently by A. Ruark. [See Abstract 328 (1940).] Author.

See Abstracts 1996, 1997, 2274.

MECHANICS, CLASSICAL.

See also Abstracts 2011, 2013.

MECHANICS, QUANTUM.

2021. Solutions of equations for particles of spin 0 or 1 when no field is present. A. H. Taub. *Phys. Rev.,* **57,** *pp.* 807–814, *May* 1, 1940.—

Belinfante's 4-component spinor form of the equations investigated by Kemmer [see Abstracts 4464 and 4466 (1939)] for particles of spin 0 and 1 are obtained in general co-ordinate systems. These equations are then solved, when no external field is present, by means of 2 simple spinors which satisfy Dirac equations for particles of spin $\frac{1}{2}$. The results previously obtained for the vector case hold for the pseudo-scalar case with one additional condition which says that the spins must be oppositely oriented. The pseudo-vector and scalar cases have similar conditions. In these cases the results differ from the previous 2 in that if one particle of spin $\frac{1}{2}$ satisfies a Dirac equation with a positive mass term then the other satisfies one with a negative mass term. AUTHOR.

2022. Field theories for charged particles of arbitrary spin. L. I. SCHIFF. *Phys. Rev.*, **57,** *pp.* 903–905, *May* 15, 1940.—A class of field theories that are invariant under the complete Lorentz and gauge groups is discussed. These theories employ wave fields that provide irreducible representations of the space rotation group, so that the particles described by them have a definite spin. The Pauli-Weisskopf and Dirac theories are of this type, and apart from them there is just one theory for each value of the spin $\geqq \frac{1}{2}$ (the present theory for spin $\frac{1}{2}$ is different from the Dirac theory). There are in each of these cases 4 states of the field for a given momentum and spin orientation : both signs of energy and both signs of charge. Quantization according to the exclusion principle can be made to result in a positive definite energy, but this prevents the charge densities from commuting outside the light cone. It seems therefore that these theories do not correspond to reality. AUTHOR.

2023. Relativistic wave equations of Dirac for particles with arbitrary spin. G. GENTILE. *N. Cimento,* **17,** *pp.* 5–12, *Jan.*, 1940.—The equations given by Dirac for particles of arbitrary spin are written in a new form, and their relation with a wave equation given by Majorana is discussed. R. P.

2024. Theory of the deuteron. J. SOLOMON. *Comptes Rendus,* **210,** *pp.* 477–478, *March* 27, 1940.—Using a proton-neutron interaction derived from the meson theory (which leads to an infinite binding energy) the conclusion is drawn that the contribution of the ^{3}D wave function to the normal state of the deuteron amounts certainly to less than 40%. R. P.

2025. Covariant derivative of tensor-undors. F. J. BELINFANTE. *Physica,* **7,** *pp.* 305–324, *April,* 1940. *In English.*—A mathematical operation is defined which is covariant under general transformations of space, and which can be applied to any " undor," i.e. to any product of an even number of spinors. This expression represents the generalization of the ordinary covariant differentiation of a tensor, as used in general relativity. R. P.

2026. Theory of the electric charge and the quantum theory. Part II. H. T. FLINT. *Phil. Mag.*, **29,** *pp.* 417–433, *May,* 1940.—Continuing previous work [see Abstract 1727 (1940)] a set of field equations are deduced for a 5-dimensional continuum, corresponding to the electromagnetic field equations. A vector ψ is introduced in analogy with the scalar and vector potentials of electromagnetic theory, and the equation satisfied by ψ reduces, for no electromagnetic field, to a fundamental equation in the wave mechanics of the free electron. The energy tensor is next considered, and it is shown that the energy density consists of 2 parts, one dependent and the other independent of the electromagnetic field. There are no negative values of energy. The process of quantization is then undertaken by replacing momentum components and co-ordinates by matrices; the element of length $d\sigma$ being defined in terms of 5 matrices thus: $d\sigma = \gamma_\mu dx^\mu$ ($\mu = 1$ to 5). The principle invoked is that in microscopic physics the matrix length and matrix vectors replace ordinary lengths and vectors. The paper concludes with an exposition of matrix geometry. J. P. A.

2027. Flint's 5-dimensional theory of electron. W. Band. *Phil. Mag.*, **29**, *pp.* 548–552, *June*, 1940.—By adopting a different unit for the fifth co-ordinate from that used by Flint [see Abstract 2979 (1931)] the fifth component of momentum becomes equal to the spin momentum, $\frac{1}{2}h/2\pi$, and the fifth geodesic equation gives the spin frequency equal to twice the de Broglie frequency. This suggests that the fifth dimension is the angle of spin, the particle spinning through 2π once per half de Broglie wave. The relativity ambiguity of length is now periodic in time with the same period as the de Broglie waves. Flint's deduction of the first-order wave equation is unaffected by the new choice of units. [See Abstracts 1561 (1937), 2152 and 4470 (1938).] Author.

2028. Reciprocity. Part II. Scalar wave functions. M. Born and K. Fuchs. *Roy. Soc. Edinburgh, Proc.*, **60**, 1, *pp.* 100–116, 1939–1940.—The theory suggested in Part I [see Abstract 3896 (1939)] is improved by taking into account the different character of the 4-vectors x^k and p_k (the former being space-like, the latter time-like), by using an invariant element of integration and by introducing terms corresponding to negative values of energy and retardation time. A new formulation of the integral equation of Part I is given in terms of " relativistic Fourier coefficients " defined with the help of a new definition of " invariant scalar products". The wave equation in x, t- and p, E-space is transformed into 4-dimensional polar co-ordinates and solved by a product of functions each depending on 1 co-ordinate only. It is shown that these functions consist of a Bessel function of the 4-dimensional distance multiplied by a pseudo-spherical harmonic which is closely connected to the 6-vector representing the angular momentum in 4-dimensional space. This harmonic depends, apart from the usual quantum numbers l and m, on a new quantum number k, which assumes the values 0, 1, 2, . . . $l - 1$; the eigenvalues of the norm of the 6-vector angular momentum are $h^2k(k + 2)$. These solutions are quadratically integrable in x, t-space, but not in p, E-space; they have relativistic Fourier coefficients in both spaces. It is proved that the Fourier coefficient of ψ_{klm} in x, t-space is proportional to the reciprocal function ϕ_{klm} in p, E-space, but not *vice versa*. [See following Abstract.] Authors.

2029. Reciprocity. Part III. Reciprocal wave functions. M. Born and K. Fuchs. *Roy. Soc. Edinburgh, Proc.*, **60**, 2, *pp.* 141–146, 1939–1940.—The attempt to find reciprocal wave functions made in Part II [see preceding Abstract] led to some difficulties. The authors believe that these were due to an incorrect definition of the relativistic scalar product and Fourier coefficient. They show in this paper that a modification of these definitions leads to simpler equations which allow the reciprocal wave functions to be determined and a transcendental equation for $\mu = a\epsilon/h$ to be found as was envisaged in Part I. [See following Abstract.] Authors.

2030. Reciprocity. Part IV. Spinor wave functions. K. Fuchs. *Roy. Soc. Edinburgh, Proc.*, **60**, 2, *pp.* 147–163, 1939–1940.—Solutions of the Dirac equation are found which are quadratically integrable on the hyperboloid $r^2 - t^2 = a^2$. If **M**, **N** is the generalized 6-vector representing the angular momentum, $\mathbf{s}^M$, $\mathbf{s}^N$ the matrices representing the magnetic and electric moment of the electron, and ${}^s\mathbf{M} = \mathbf{M} + h\mathbf{s}^M/2$, ${}^s\mathbf{N} = \mathbf{N} + h\mathbf{s}^N/2$, then the solutions of the Dirac equation can be classified with respect to the proper values $h\mu$, $h^2\lambda(\lambda + 1)$, $h^2\{\kappa(\kappa + 2) + \frac{1}{4}\}$ of the operators ${}^sM_z$, ${}^sM^2$, ${}^sM^2 - {}^sN^2$. Here κ, λ, μ are half-integers. [See preceding Abstract.] AUTHOR.

2031. Hydrodynamics of electron gas. D. BLOKHINTSEV. *Mém. Phys. Ukrainian S.S.R.*, **8**, 2, *pp.* 143–147, 1940. *In Ukrainian.*—The hydrodynamics of the electron gas is discussed and the Thomas-Fermi expression for its energy at rest as corrected by Weiszäcker [see Abstract 4427 (1935)] is obtained by making the velocity zero. D. S.

See also Abstracts 1961, 2035, 2223, 2242, 2243.

PRESSURE.

***2032. High pressures.** J. BASSET. *J. de Physique et le Radium*, **1**, *pp.* 121–123, *April*, 1940.—It has now been possible to attain, in the laboratory, pressures amounting to between 50 000 and 75 000 kg./cm^2., i.e. a pressure greater than those obtained by Bridgman's method. This has been done by making the cylinders and pistons of the apparatus out of blocks of metallic carbides of great hardness. The cylinders themselves were constructed out of concentric tubes, bound together by iron hoops, so as to withstand the centripetal pressure. An increased pressure range of from 75 000 to 100 000 kg./cm^2. can be obtained by using the apparatus at very low temperatures, whereby the elastic limit of the materials is raised. G. G.

***2033. Design of fractionating pumps.** K. C. D. HICKMAN. *J. of Applied Physics*, **11**, *pp.* 303–313, *May*, 1940.—The factors limiting the efficiency of fractionating diffusion pumps are discussed and the reasons for continuing the evolution of the design of the horizontal type of fractionating pump are briefly stated. Early pumps of this type were found to suffer from minor defects. An improved design employing the high speed Embree jet (a vertically downward, inwardly expanding jet), is described. Pumps of 4, 8, and 21 in. have been built and their performances examined. As a result, considerable information has been obtained concerning such points as whether to fractionate in the vapour phase only or in both vapour and liquid phases, jet design, testing and speed measurement, baffles and traps, and pump fluids. [See Abstracts 2044 and 2045 (1936).] S. W.

***2034. Quartz-fibre manometer.** G. WETTERER. *Zeits. f. techn. Physik*, **20**, 10, *pp.* 281–283, 1939.—A manometer, depending on the property that the damping of an oscillating quartz fibre depends on the gas pressure at low pressures, is developed using 2 quartz threads in the form of a V. A formula is given involving the gas pressure and the half-value time of the oscillating apparatus. Curves are given showing good agreement between the formula and experimental results. The instrument is serviceable down to pressures of 10^{-7} Torr. G. O. B.

RELATIVITY AND ETHER.

2035. Equations of motion in electrodynamics. L. INFELD AND P. R. WALLACE. *Phys. Rev.*, **57**, *pp.* 797–806, *May* 1, 1940.—A formulation of the equations of motion of singularities in classical electromagnetic theory is obtained. The general method introduced by Einstein, Infeld and Hoffmann leads in a simple way, without any difficulty with "infinities," to the equations of motion obtained before by Dirac. It is shown further that Dirac's introduction of the inertial term into the equations of motion corresponds in this method to the assumption of an energy-momentum tensor of matter. The attempt to remove this arbitrary assumption leads in a simple and natural way to the general theory of relativity, in which the equations of motion are obtained from the Einstein-Maxwell field equations. AUTHORS.

See also Abstracts 2025, 2026, 2244.

SOLUTION.

2036. Influence of degree of dispersion on physico-chemical constants. Parts VII, VIII and IX. E. COHEN AND J. J. A. BLEKKINGH, JR. *K. Ned. Akad. Wet., Proc.*, **43**, 1, *pp.* 32–40; **43**, 2, *pp.* 189–197, *and* **43**, 3, *pp.* 334–339, 1940. *In German.*—Conductivity and polarographic determinations are described in detail, showing that the degree of dispersion has no influence on the solubility of chemically and physically pure $BaSO_4$. Its solubility at 25° is 2·43 mg./l., and the solubility product $1{\cdot}08 \times 10^{-10}$. [For Part VI see Abstract 2037 (1936).] C. A. S.

2037. Unstable boundary-layer solutions. H. DUNKEN. *Zeits. f. phys. Chem. B*, **46**, 1, *pp.* 38–42, 1940.—Boundary-layer solutions occur when the molecules of a substance are soluble with 2 different components in 2 neighbouring liquids. It can be shown, with the help of observations of the boundary-layer tensions in the system water, stearic acid, hexane, that the acid dissolves first in the boundary layer between water and hexane. From the boundary layer the acid passes into hexane. Consequently, stearic acid dissolves much quicker in hexane spread on a surface of water than in hexane alone. [See Abstracts 1196 (1935) and 3555 (1938).] L. K.

2038. Solubilities of chlorides of La, Pr and Nd. J. N. FRIEND AND R. W. HALE. *Chem. Soc., J.*, *pp.* 670–672, *May*, 1940.—Between 0° and 80° the solubilities of the heptahydrated chlorides of praseodymium and lanthanum are almost identical. Above 55° $NdCl_3,6H_2O$ is appreciably less soluble than either of these salts. AUTHORS.

2039. Properties of Eu salt solutions. L. HOLLECK. *Zeits. f. Elektrochem*, **46**, *pp.* 69–71, *Feb.*, 1940.—The change from Eu^{+++} to Eu^{++} was investigated by measuring current/potential curves using aqueous solutions of various concentrations of $EuCl_3$ and $Eu(NO_3)_3$. The results so obtained are compared with those obtained by experiments on the absorption and fluorescence spectra of Eu salts. The existence of 2 structure types of solution separated by an intermediate transformation region is confirmed, G. G.

See also Abstract 1989.

SURFACE PROPERTIES.

2040. Adsorption at interface between two fluids. Part III. C. W. GIBBY AND C. ARGUMENT. *Chem. Soc., J.*, *pp.* 596–600, *May*, 1940.—The adsorptions of methylene-blue, Congo-red, Bordeaux extra, indigo-carmine X, and Solway ultra-blue B at Hg-aqueous solution interfaces have been measured. In each case the adsorption passes through a maximum as the concentration increases and is always positive. Interfacial-tension measurements have also been made and values of the adsorption calculated from them by means of Gibbs's equation. These are not in agreement with the measured values and are in some cases negative. [For Part II see Abstract 4927 (1936).] AUTHORS.

2041. Size of drops. H. NEUMANN AND R. SEELIGER. *Zeits. f. Physik,* **114,** 9–10, *pp.* 571–578, 1939.—The relation between the size of liquid drops and the velocity of formation has been investigated experimentally for liquids of differing surface tension and viscosity. On cinematographic films the formation of the drops was observed until the moment when they fell off. The drop weight shows a maximum for a small time of formation. This maximum shifts to smaller formation times with increasing viscosity and with decreasing surface tension. The mean velocity of flow of the liquid into the drop increases linearly with the surface tension. The contraction of the drop at the upper end develops independently of the formation time. An attempt is made to explain these phenomena dynamically. L. K.

2042. Computation of physical properties of lubricating oils at high pressures. Part I. Density. R. B. DOW and C. E. FINK. *J. of Applied Physics,* **11,** *pp.* 353–357, *May,* 1940.—From a survey of available data on the density of fluid lubricants as a function of pressure and temperature the following empirical equation has been derived : $\rho = \rho_0(1 + ap - bp^2)_t$; ρ is the density at a given pressure (gauge) p and temperature t ; ρ_0 is the corresponding density at 1 atm. pressure. The constants a and b are evaluated over a temperature range extending from 20° to 220°F. and the density equation is valid over a pressure range of 50 000 lb./in². While the equation was derived from data on mineral oils it has been found to hold equally well for animal, vegetable, and fish oils. The variation of density with pressure is independent of the nature of the oil. AUTHORS.

See also Abstracts 2009, 2037, 2045, 2117, 2189, 2230, and
1142B. Lubrication. Part VII. M. Muskat, F. Morgan and M. W. Meres.

TIME.

See Abstracts
1201B. New time standard. H. E. Warren.
1203B. Photo-electric time-interval meter. T. M. Berry.

VISCOSITY AND FRICTION.

***2043. Viscosity measurement in critical region. Ethylene.** S. G. MASON AND O. MAASS. *Canad. J. of Research, B,* **18,** *pp.* 128–137, *May,* 1940.—A precision oscillating disc viscometer has been constructed with a view to studying viscosities of systems at the critical temperature and critical pressure. A new method of computing logarithmic decrements is described and a number of results obtained with ethylene are presented. Of particular interest is the transition in viscosity on an isochore through the critical temperature. AUTHORS.

2044. Viscosity and constitution. A. H. NISSAN, L. V. W. CLARK AND A. W. NASH. *J. Inst. Petroleum,* **26,** *pp.* 155–211, *April,* 1940.—It is argued, both on the basis of a formula connecting the molal latent heat of vaporization with the melting point of monatomic liquids and on experimental results obtained with 137 representative liquids, that one continuous viscosity-temperature formula must exist for all flowing matter, with various terms, depending on the state of the matter and the nature of the flow, predominating. Viscosity and vapour pressure are functions of essentially the same variables. The heat of activation of viscosity is a function of temperature even for *n*-paraffins, so the chief

distinction between associated and unassociated liquids from the point of view of viscosity disappears in principle. The molecular shape rather than dipole moments or the nature of the atoms was shown to regulate the viscosity characteristics. Association, like viscosity, is shown to be a function of the ratio of the temperature to the temperature of boiling, and following these lines it appears that a liquid composed entirely of cyclic structure with the rings all joined end-on would have a high viscosity index. Some elements afford important anomalies, and study of these elements showed that there is a hitherto unsuspected rise in viscosity at the boiling point for all liquids. Thus the chief distinction between gases and liquids with regard to viscosity disappears. Substances are arranged in the following order as regards the predominance of the term defining fall of viscosity with rise of temperature: gases at low pressure, gases at high pressure, helium, metallic elements, non-metallic elements, unassociated liquids, associated liquids, non-Newtonian liquids, plastics, and crystals.
P. H. B.

2045. Figures in thin layers of grease and viscous liquids. W. D. KUMLER. *J. Phys. Chem.*, **44**, *pp.* 612–618, *May*, 1940.—Figures are formed in greases or liquids of the proper viscosity when the substance is placed between smooth plates and pressure is applied and subsequently released. The figures are holes in the material, and their shape depends upon the viscosity and composition of the material used. The figures are formed in a wide variety of chemical compounds, including the very polar and the very non-polar. There is no parallel between compounds that form the figures and compounds that form liquid crystals. The viscosity and "stickiness" of the material were the only properties that were observed to be associated with ability to form the figures. AUTHOR.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

***2046. Solid-glass Schmidt camera and new type nebular spectrograph.** J. G. BAKER. *Am. Phil. Soc., Proc.*, **82**, 3, *pp.* 323–338, 1940.—The complete fifth-order theory of image errors is applied to both the solid-glass Schmidt camera and to the usual kind of Schmidt camera. The fifth-order defect most important in the formation of images by the Schmidt camera is that called the variation of spherical aberration with angle. The Schmidt camera can be made completely aplanatic, but the resultant optical surfaces differ from those for minimum chromatic aberration. The equation of the meridian section of the correcting surface is developed through tenth-order terms in order to obtain the curve of the correcting surface to sufficient accuracy for the fastest cameras. The fifth-order theory permits a solid Schmidt camera of the limiting focal ratio of $f/0{\cdot}30$ and a field of 7° to be made. An exact calculation indicates that the fifth-order terms, even at $f/0{\cdot}30$ and over a 7° field, represent within 10% of the exact value the numerical size of the image aberrations and are completely adequate for slower cameras and moderate fields. The solid Schmidt of $f/0{\cdot}30$ is to be used as the camera in a new type nebular spectrograph. A prism arrangement is presented that affords the advantages of cheapness, compactness and low light absorption. In addition to one or more small 60° dispersing prisms from 2 to 4 30–60° prisms are added in order to spread the collimated beam of circular cross-section into a beam of elliptical cross-section entering the camera. This device yields the above advantages without loss of speed or definition at a given dispersion. The coating of the glass surfaces in such a system is recommended in order that the total efficiency be within 90% of the theoretical limit. The prism device enables the solid Schmidt to be used off-axis without loss of light and thus affords easy access to the focal surface. [See following Abstract.] AUTHOR.

***2047. Family of flat-field cameras, equivalent in performance to the Schmidt camera.** J. G. BAKER. *Am. Phil. Soc., Proc.*, **82,** 3, *pp.* 339–349, 1940.—A 2-parameter family of telescopes is described that have the desirable properties of being aplanatic and anastigmatic on a flat field. Distortion, unimportant for astronomical purposes, is small; for one member of the family distortion is zero. Each member of this family of cameras is equivalent in optical performance to the Schmidt camera. The tube length can be made as short as $\frac{1}{3}$ the focal length. All members of the family of cameras have a correcting plate, a primary concave mirror and a secondary convex mirror. The 2 parameters remaining after the conditions for aplanatism and anastigmatism have been satisfied are the distance of the correcting plate from the primary mirror and the distance of the photographic plate from the secondary mirror. A large field can be obtained free from vignetting. The 2 mirror surfaces are aspherical for all but a single-parameter family for which the surfaces are so closely spherical as to require but a small fraction of the figuring of a paraboloid of the same focal length. Even in the case where both mirrors are aspherical there exist no inflection points to complicate manufacture. The curves of the optical surfaces can all be expressed as rational functions of the parameters. The properties of the families of the Schmidt and Schwarzschild mirror systems are discussed relative to this family of cameras. [See preceding Abstract.] AUTHOR.

***2048. Null test for concave mirrors.** S. C. B. GASCOIGNE. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 462–487, *April,* 1940.—Methods are described for null-testing concave mirrors at centre of curvature by interposing figured plates between the star and mirror to compensate their spherical aberration. The plates are themselves null-tested by normal incidence interference against the figured back of a pseudo-plane convex lens which is in turn null-tested autostigmatically. The method admits of wide application; for example, a 190 cm. $f/5$ paraboloid tested in this manner with a 19 cm. diameter plate would not be in error by more than $\pm 2{\cdot}5 \times 10^{-5}$ mm. [In an *Appendix* (*ibid. pp.* 488–490) C. R. BURCH discusses the Williams interferometer.] AUTHOR.

COMETS AND METEORS.

2049. Fireball radiant positions. F. WATSON. *Am. Phil. Soc., Proc.*, **81,** 4, *pp.* 473–479, 1939.—The reality of the published hyperbolic velocities for a large portion of bright meteors, which would require their origin in interstellar space, is considered. Their directions of motion, corrected for the effects of the earth's motion, show a definite concentration toward the plane of the solar system. When compared with meteor streams, which almost certainly belong to the system, the bright meteors exhibit an equal if not higher degree of concentration about the ecliptic. Since the study of photographed meteors, which are comparable to fireballs in brightness, has revealed no hyperbolic velocities, and since the directions of motion of fireballs and meteor streams are practically indistinguishable, it seems probable that the velocities previously assigned to the fireballs were too great and that the bodies are permanent members of the solar system. AUTHOR.

2050. Apparent distribution of meteoroid orbits. F. WATSON. *Am. Phil. Soc., Proc.*, **81**, 4, *pp.* 481–491, 1939.—By use of a simple spherical reduction the important elements of parabolic orbits are determined for meteor showers. Despite unfavourable influences from their geocentric velocities the majority of the streams appear to be moving in the same direction as the earth about the sun and in orbits not greatly inclined to the plane of the solar system. Streams with perihelion at approximately the earth's distance from the sun are found to be the most frequent. AUTHOR.

2051. Telescopic meteors. F. WATSON. *Am. Phil. Soc., Proc.*, **81**, 4, *pp.* 493–504, 1939.—The number of faint meteors that enter the earth's atmosphere each day may be derived from the frequency observed with a telescope of given field diameter, provided the fraction of the atmosphere under effective observation can be determined. This area is related to the path lengths of the meteors, which vary with the meteors' brightness. The probability that a meteor of length L will begin in, end in, cross, or both begin in and end in a field of diameter D is determined in terms of the ratio L/D. From the tables the average path length for meteors of a given brightness can be determined. A scheme is devised by which the magnitude scales for telescopic and naked-eye observations may be joined. From the study of a set of observations the path lengths are found to decrease from 12 km. for fifth magnitude meteors to about 1 km. for tenth magnitude objects. Daily frequencies over the whole earth are determined; these show an increase of $2 \cdot 7$ in the frequency for each fainter magnitude. At the ninth magnitude alone the daily rate is approximately 10^9 meteors. AUTHOR.

2052. Binocular observations of 718 meteors. J. D. WILLIAMS. *Am. Phil. Soc., Proc.*, **81**, 4, *pp.* 505–520, 1939.—The purpose of the paper is to present for study data on faint meteors, secured under circumstances which were optimum to the limit permitted by classical observing methods. The observer was practised, the equipment was well adapted to the problem and sky conditions were excellent throughout. AUTHOR.

2053. Systematic biases of meteor directions. J. D. WILLIAMS. *Am. Phil. Soc., Proc.*, **81**, 4, *pp.* 521–524, 1939.—Data concerning the apparent directions of flight of meteors have been utilized principally in the determination of radiants, but the possibility of deducing from them some of the characteristics of the spatial and velocity-distributions is now receiving attention. This note serves to draw attention to 2 circumstances which affect the distribution of apparent directions in a systematic manner; one effect occurs only when observations are made in a restricted region of the sky and, consequently, is of interest when discussing telescopic meteors. The biases are illustrated quantitatively by consideration of an idealized distribution. Both effects enhance the number of meteors whose altitudes decrease during flight. AUTHOR.

2054. Photographic meteor studies. Part II. Non-linear trails. F. L. WHIPPLE. *Am. Phil. Soc., Proc.*, **82**, 3, *pp.* 275–290, 1940.—Several

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meteor trails on plates taken with the larger Harvard patrol cameras have been found to be sinuous, with total amplitudes up to 30 μ. The sinuosity of these trails is shown to have been caused by the vibration of the cameras and not to have originated in the meteors themselves. In one case the vibration was maintained by the one-impulse-per-sec. motion of the camera drive. The frequency of 20 vibrations per sec. has been determined from a long meteor trail and represents the natural vibration of the camera. In a second case a forced vibration of 16 per sec. was maintained by the continuously operating motor drive. The oscillations in the trails can be used in exactly the same fashion as interruptions from a rotating shutter for the determination of angular velocities, radiants, heights and linear velocities. A Geminid trail provided a satisfactory check on the method, as did deceleration measures near the end of a long trail. The spatial orbits of 2 sporadic meteors have been determined and found to be elliptical. Numerical data concerning the physical process of splitting have been deduced for a long trail which divided near the end. Splitting is probably caused by the thermal expansion of the outer layers of the meteoroid when it enters the earth's atmosphere. [For Part I see Abstract 157 (1939).] AUTHOR.

2055. Seasonal variation in height of meteors. R. A. MCINTOSH. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 510–528, *May,* 1940.—All available published real paths of meteors, both British and foreign, were used in an attempt to confirm the seasonal variation found by Öpik [see Abstract 1012 (1938)] in the centre of trails observed by the Harvard Meteor Expedition. Öpik having asserted that harmonic mean height should be used in discussions of heights, as the arithmetic means were subject to errors of observation, the data were examined from a statistical viewpoint and it is shown that in the present instance it is correct to use the arithmetic means. Examples of errors arising from the use of harmonic means are given. It was found necessary to exclude shower meteors from the data, as they began and ended up to 14 miles higher than the sporadic meteors. Some possible explanations are indicated. The slightly greater range of heights found by Öpik in shower meteors is not confirmed, the average shower meteor in the author's data having a shorter range than the sporadic. The data, after excluding the shower meteors, reveal a well-marked seasonal variation in the 3 points examined. The amplitude of the variation is greatest in the lower levels of the atmosphere, where maxima and minima appear to occur earlier than in higher levels. These facts indicate that the cause of the variation lies in the atmosphere itself. A similarly well-marked seasonal variation is found in the width of the meteor zone. For direct comparison with the Harvard data the harmonic mean heights are also given, and, while there is close agreement between their results and those of the author, several weaknesses in the use of harmonic means are exposed. In a consideration of the accuracy of the visual meteor heights used in this paper the high standard of accuracy and the value of this material are defended. AUTHOR.

PLANETS.

2056. Radiation measurements on the eclipsed moon. E. PETTIT. *Mt. Wilson Observat. Contrib., No.* 627. *Astrophys. J.,* **91,** *pp.* 408–420, *May,* 1940.—The measurements were made on the lunar eclipse of Oct. 27, 1939, with a thermocouple attached to the 20 in. telescope of 40 in. focal length. The deflection on total radiation at the end of totality was 54 mm., more than 36 times that previously observed. Both cover glass and water cell were used to determine the temperatures. For a point near the centre of the disc which was chosen for measurement the temperature fell from 371° to 200° K. during the first partial phase and slowly dropped to 175°K. during totality. At the beginning of totality the temperature fell at the rate of 30°C. per hour, but at the end of the first hour the rate was 7°C. per hour. The rate of radiation is nearly proportional to the energy received, except for very low temperatures. A computation of the equivalent thickness of the radiating layer from the known physical constants of lava and the radiation data shows that about 2·6 cm. will satisfy the conditions. [See Abstract 2772 (1930).] AUTHOR.

STARS.

2057. Masses, radii, and other absolute dimensions for 224 eclipsing variables. S. GAPOSCHKIN. *Am. Phil. Soc., Proc.*, **82,** 3, *pp.* 291–322, 1940.—The eclipsing variables are of extreme importance for an understanding of stars in general. During the last 25 years the material relating to these variables has grown to such an extent that their properties may be studied from a limited point of view, and also may be viewed as a whole. Both of these aspects are treated in the present paper; 224 systems are discussed. The principal results may be summarized as follows: (1) Absolute dimensions for 448 single components are derived, with a description of the method. (2) An expression is derived for the relation between mass and radius, which is given numerically in the form of a table. (3) Other relations between the absolute dimensions are illustrated and discussed. AUTHOR.

2058. Stars with composite spectra. R. TREMBLOT. *Bull. Astronomique*, **11,** 8, *pp.* 377–407, 1938.—Double and triple stars with widely different components are easy to recognize and catalogue and their orbital motions are readily determined. Most are giants with small proper motions and parallax and are near the Galaxy; 20 stars, with the instruments and methods of measuring them, are given with their visual magnitudes and types. A. S. D. M.

2059. Dispersion in estimates of spectral type. H. E. BUTLER AND A. D. THACKERAY. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 450–461, *April*, 1940.—Individual dispersions of estimates of spectral types can only be found if there are at least 3 independent classifications available whose accidental errors are uncorrelated. Using the Victoria, Mount Wilson and Harvard classifications and assuming their accidental errors to be uncorrelated, dispersions of the 3 estimates are calculated for 6 groups of types from A0 to K5. In the types A0 to F5 Harvard and Victoria errors are positively correlated and both are negatively correlated with Mount Wilson errors ; this is attributed to the choice of criteria. In these conditions the problem becomes insoluble however many catalogues are available. Some results, however, can be obtained by using 2 additional classifications, by Abetti and A. V. Douglas, and by making certain assumptions about the correlation of accidental errors in the light of knowledge about the criteria used. The use of new criteria for A-type stars (e.g. u.v. lines) is recommended. The Harvard classification of K dwarfs is subject to systematic errors which increase for fainter stars. The classification of K giants appears to be free from errors associated with apparent magnitude. In units of tenths of a spectral type the standard errors of the Victoria, Mount Wilson and Harvard classifications of stars

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brighter than 6^m to 7^m vary between 1·0 and 1·6, 1·3 and 1·6, 1·9 and 2·7, respectively. AUTHORS.

2060. Effect of continuous Balmer absorption upon equivalent widths of stellar absorption lines. O. STRUVE AND F. SHERMAN. *Astrophys. J.*, **91**, *pp.* 428–437, *May*, 1940.—Continuous Balmer absorption on the violet side of λ 3647 tends to weaken the absorption lines of various elements. From the equivalent widths of 48 lines of Ti H the ratio of the continuous absorption coefficients on both sides of λ 3647 is found to be 16 in η Leonis, 10 in α Cygni and α Lyrae, and 2 in ν Sagittarii. The hydrogen abundance is very great in η Leonis, α Cygni, and α Lyrae but is surprisingly low in ν Sagittarii. AUTHORS.

2061. Contours of Hγ in A-type stars. C. J. KRIEGER. *Astrophys. J.*, **91**, *pp.* 476–478, *May*, 1940.—The contours of Hγ in 14 A-type stars are measured, and their half-width and those of additional stars are found. The half-width shows a strong dependence on the absolute magnitude, increasing from 1·6 Å for giants to 26·6 Å for white dwarfs. AUTHOR.

2062. Accretion and stellar energy. R. D'E. ATKINSON. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 500–509, *May*, 1940.—The methods of elementary dimensional analysis are applied to the question of determining the maximum possible rate of accretion of diffuse matter by stars. It is found that, if the rate of accretion is given by any product formula involving only powers of the star's mass and radius, its velocity with respect to the diffuse matter, the mean density of the matter and the constant of gravitation, then the problem of the radiation of the bright stars cannot be solved by any admissible accretion formula at all; indeed, considerable dynamical results are possible only if extreme values of the parameters are postulated, and even then only if the time scale is extended to 10^{10} years or more, in which case the radiation problem is further aggravated. Thus either some such additional factor as the molecular nature or molecular state of the diffuse gas is explicitly relevant, or else the rate of accretion is not given by any simple product formula at all, or, finally, the total radiation of the bright stars requires some additional source of energy beyond that provided by all the hydrogen they initially possessed and all they can subsequently collect. AUTHOR.

2063. Dark matter in the star system. C. SCHALÉN. *Naturwiss.*, **28**, *pp.* 81–88, *Feb.* 9, 1940.—A review of recent work in this subject relating to such interstellar matter as causes a weakening of starlight and has a bearing on views of the structure of the star system. A diagram of Hubble showing the distribution of outer galactic mist in galactic co-ordinates is given, and also colour curves of certain stars due to Baade and Minkowski. J. J. S.

2064. Perseus cluster. W. M. SMART AND A. ALI. *Roy. Astron. Soc., M.N.*, **100**, *pp.* 560–569, *May*, 1940.—The convergent point of 45 stars, assumed to belong to the Perseus cluster, is found to be (108°, − 36°); the "cluster-velocity" is about 26 km./sec. The parallax and absolute magnitude criteria are in accordance with cluster motion as regards the bulk of the stars. The radial-velocity criterion rules out a considerable proportion of the stars as members of a possible cluster. The mean random radial speed of all the stars with measured radial velocities is about 4½ km./sec., considerably less than the value usually attributed to the B stars in general. The paper is not definitely conclusive as to the real cinematical characteristics of the stars investigated; it is possible that a nucleus of stars, indicated in Table V of the present paper, may form a moving cluster. AUTHORS.

2065. Corona Borealis cluster. A. ALI. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 570–573, *May,* 1940.—The motions of the stars in the environs of Corona Borealis as given by Rasmuson are subjected to 3 different criteria for common cluster motion. It is shown that the position-angle criterion is satisfied tolerably for about half of the stars by taking the convergent point as (270°·3, — 42°·6). The parallax criterion is inconclusive as a whole, and the assumption of common cluster motion fails signally in the case of radial velocities. Hence it is concluded that no common motion exists in the case of the Corona Borealis stars. AUTHOR.

2066. 61 Cygni cluster. P. C. CHAUDHURI. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 574–580, *May,* 1940.—The stars of the so-called 61 Cygni cluster have been divided into 3 sub-groups, and the convergent point and stream motion of each are calculated. It is concluded that cluster motion is absent from the first 2 sub-groups, the members of which are mainly " high-velocity stars," and that probably several stars in the third sub-group are members of the Taurus cluster. AUTHOR.

2067. Boss 5442 (V389 Cygni). Part II. P. GUTHNICK. *Preuss. Akad. Wiss. Berlin, Abhandlungen, No.* 6, [29 *pp.*], 1939.—Following on the brightness and spectroscopic measurements of Boss 5442 (V389 Cygni) reported in Part I of this paper [see Abstract 1065 (1938)] further observations made in 1937 and 1938 are reported which lead to clarification of the complex variations of this star. The assumption which now appears in best accord with the observational material is that V389 Cygni consists of 2 component stars with a period of rotation of $3{\cdot}313^d$; of these only the bright component is spectrographically visible and the weak has no effect on the total brightness of the system; the bright oscillates with the larger amplitude in a period of $1{\cdot}12912^d$ and the faint with a period of $1{\cdot}19328^d$. In Part I of this paper it had been deduced that the faint component had the period now ascribed to the bright one and that the latter was invariable. Further measurements are required to check the new assumption. J. E. K.

2068. Change in period of RW Sagittarii. P. M. RYVES. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 491–494, *April,* 1940.—Further observations of RW Sagittarii confirm the results previously obtained, viz. that the variation is of long-period type and small amplitude with the irregularities which frequently accompany these characters. A period of 188 days satisfies the observations up to 1926, when a change took place to 191 days. About the time of this change of period the light-curve shows peculiar irregularities, including indications of a second wave or inflection with a period of about 172 days, and a superimposed short-term variation, period 22 days. AUTHOR.

2069. Relative dimensions of shells around Nova Herculis 1934. W. S. TAI. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 435–449, *April,* 1940.—The central absorption of Balmer absorption components, the D lines, and a few TiII lines in Nova Herculis are measured on selected spectrograms, and the relative dimensions of the shells around the nova are deduced from the measured results. Electron pressures of the H absorbing shells are calculated by a method described by Mohler [see Abstract 162 (1940)]. AUTHOR.

2070. Relation between absorption velocity and rate of decline for galactic novae. D. B. McLaughlin. *Astrophys. J.*, **91,** *pp.* 369–378, *May,* 1940.—The relations between times of decline of light and the velocities of the principal and diffuse enhanced absorption spectra are determined from observations of 21 galactic novae. These agree closely with relations between rates of development of spectra and the absorption velocities of 6 bright novae, as previously found by the author [see Abstract 3464 (1937)]. It is concluded that (1) the spectral stage is a function of the difference of magnitude from maximum; (2) the time of decline or of spectral change is inversely proportional to the square of the velocity of the principal spectrum; and (3), in the average case, the velocity of the diffuse enhanced spectrum is twice that of the principal spectrum. The observed relations are radically different from that proposed by Zwicky, viz. the lifetime is directly proportional to the velocity. Such a relation, adjusted on a supernova, is fortuitously satisfied by some rapid common novae, but stars of slow and intermediate rate deviate very far from Zwicky's relation. Author.

2071. Necessity for spectral sub-classification, with a discussion of preliminary results for 1 300 southern stars. D. Hoffleit. *Am. Phil. Soc., Proc.,* **81,** 4, *pp.* 533–545, 1939.—The importance of the determination of spectral sub-classes as a preliminary step in the determination of spectroscopic absolute magnitudes is pointed out. Sub-classes have already been determined at Harvard for over 1 700 southern stars of types A5 through M, and mostly brighter than the seventh visual magnitude. The criteria used are listed and are discussed briefly. Accidental errors in the sub-classes will be reflected in the determinations of absolute magnitude, increasing the observed dispersion in the latter for a given observed spectral sub-class. A comparison between the total observational error-dispersion and the " true " dispersions in the absolute magnitudes appears to indicate that the Harvard sub-classes are sufficiently accurate to justify the continuance of the absolute magnitude determinations. The Harvard sub-classes are compared with the Henry Draper classes and with the sub-classes determined at Mount Wilson and at Bonn. Various possible sources for small systematic differences are considered and it is found that the use of somewhat poorly exposed plates may become an important source of error. Author.

2072. Fog effect in photographic astro- and spectro-photometry. G. Alter, D. R. Barber and D. L. Edwards. *Roy. Astron. Soc., M.N.,* **100,** *pp.* 529–545, *May,* 1940.—The magnitude or density difference between 2 successive equal exposures on one plate is shown to be due almost entirely to the effect of fogging background light. A short historical survey is given, and it is shown that the humidity effect suggested by early workers is too small to be of much significance. The magnitude of the fog effect for different instruments is determined both for star diameters and spectral images. It is further shown that the photographic emulsion, the intensity of the night sky, the wavelength of the light in the principal exposures, the final density of the image, the exposure times and the aperture of the instrument, all have an influence on the magnitude of the effect. A theoretical explanation of the observed facts is suggested, based on a modern latent-image theory. Definite corrections arising from this effect cannot be given, but must be determined by individual observers to meet the conditions of their own work. Authors.

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2073. Eclipse table of the Dresden Maya-Codex. A. Dittrich. *Preuss. Akad. Wiss. Berlin, Abhandlungen, No.* 2, [47 *pp.*], 1939.—This paper comprises a detailed study and interpretation of the eclipse data recorded in pages 51 to 58 of the Dresden Maya-Codex. J. E. K.

2074. Solar corona of 1937, June 8. I. L. Thomsen. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 554–559, *May*, 1940.—The position of the observation spot on Canton Island and the observed contact times of the total solar eclipse of 1937, June 8, are given. A discussion of the corona shows that it is made up of separate distinct structures. The eastern corona appeared to be the most complicated, and attention is drawn to the fact that it probably had its origin in a very disturbed part of the sun. It is suggested that photometry of individual features of the corona might prove a fruitful source of research. Author.

2075. Mean areas and heliographic latitudes of sunspots in the year 1937. *Roy. Astron. Soc., M.N.*, **100,** *pp.* 495–497, *April*, 1940.—The results are in continuation of those previously given [see Abstract 2349 (1938)].

2076. Excitation temperature of solar reversing layer from CN (λ 3883). L. Blitzer. *Astrophys. J.*, **91,** *pp.* 421–427, *May*, 1940.—The intensities, in equivalent milliångströms, of 14 doublets in the R branch of the CN (O — O) band have been measured from plates taken for the author with the 75-ft. spectrograph of the 150-ft. tower telescope on Mount Wilson. Theoretical curves of growth for CN were computed for a number of separations of the doublet lines, and from these curves values of log *Nf* corresponding to the measured equivalent widths were determined. Because of the very strong iron absorptions in this region the equivalent widths were in all cases measured from the blending background. Thackeray's corrections to the true continuous background were then applied to the *Nf* values. On the assumption of thermal equilibrium in the solar reversing layer the excitation temperature was found to be 4 490° ± 100°K. (p.e.). Author.

See also Abstracts 2282, 2283.

GEOPHYSICS.

GEOPHYSICS, APPLIED.

See Abstract

1291B. Influence of subterranean radio-geological characteristics on propagation of electromagnetic waves. V. Fritsch.

HYDROSPHERE, PHYSICS OF THE.

2077. Time variability of hydrographic elements determining dynamic situation in western North Atlantic. H. R. Seiwell. *Am. Phil. Soc., Proc.*, **82,** 3, *pp.* 369–394, 1940.—In 1936, 1937 and 1938, repeated temperature and salinity measurements over periods of 57 to 314 hours, at fixed depths measured from the physical sea surface, in the western North Atlantic have revealed that, because of significant daily and day by day changes in the observed state of the sea, a measure of average conditions is not generally obtained from isolated individual samplings of the water column, a circumstance which reduces the significance of detail in patterns of geographic variation of oceanographic properties as deduced from data of station networks. Remarks on this phenomenon in the Atlantic basins by various authors have recently been summarized by Seiwell [see Abstract 1471 (1940)] and are dispensed with here. In this paper it is proposed (1) to present a résumé of the results of repeated temperature measurements at 3 " Atlantic " Stations (2 886, 2 887, 3 091) in the western basin of the North Atlantic and (2) to apply the results of one of these (2 887) to illustrate the effect of short-period variations on dynamic computations of the state of the western Sargasso Sea and of the Gulf Stream system off the American coast. AUTHOR.

2078. Sea-beach profiles. P. SCATIZZI. *Pont. Accad. Sci., Atti,* **4,** 10, *pp.* 73–80, 1940.—Observations were made on various sea-beaches with the object of ascertaining their general form as moulded by the action of the waves. This form is not capricious but is dependent upon the play of various forces and may be dealt with by considering the forces which act on a particle of the water, viz. (1) the weight of the particle, (2) a constant horizontal influence due to the action of the wind and indirectly to the surrounding liquid particles, and (3) the reaction of the support—the sea-beach. The bottom of the sea under these forces takes a form approximating to the cycloidal type. The paper is illustrated by diagrams and pictures of different beaches. J. J. S.

LAND, PHYSICS OF THE.

2079. Interior of the earth. R. STONELEY. *Roy. Astron. Soc., Occasional Notes, No.* 8, *pp.* 103–116, *March,* 1940.—A connected summary of the deductions as to the internal structure of the earth, based on observations (and calculations therefrom) of (1) the shape of the earth, (2) gravity, (3) nature and rates of propagation of various earthquake waves, (4) the earth's viscosity, plasticity and magnetic properties and their variations with temperature, whether resulting from the gradual dissipation of initial heat or from the presence of radioactive material. C. A. S.

2080. Measurement of soil structure. R. G. DOWNES AND G. W. LEEPER. *Roy. Soc. Victoria, Proc.,* **52,** 1, *pp.* 1–20, 1940.—The structure of soil depends on the way in which the particles of sand, silt, clay and organic matter, are arranged to form aggregates or compound units, and is best measured by the " percentage of disaggregation", which is defined as the percentage of the " Meyer fraction " $< \frac{1}{4}$ mm. (method of determination described) on the whole soil, or, where there is a considerable amount of coarse sand, on the whole soil after deduction of the amount thereof. Structure may also be measured indirectly by measuring specific physical properties thought to be connected therewith, of which the pore space of the soil *in situ* is probably the best. Application of the methods to various Australian soils is discussed in detail. C. A. S.

2081. Use of radioactive phosphorus in soil studies. S. S. BALLARD AND L. A. DEAN. *J. of Applied Physics,* **11,** *pp.* 366–370, *May,* 1940.—Some uses of radioactive P in soil and fertilizer studies have been investigated. The necessary apparatus, the technique and the accuracy of determining radioactive P in soils, solutions and plant ashes, are described and discussed and several examples of its application in agricultural problems are given. These include measurements of the rate of sorption of P by soils, fertilizer-placement studies, and measurements of the movement of applied P through a soil. AUTHORS.

See also Abstracts 2000, 2078.

METEOROLOGY.

2082. Applications of Brunt's radiation equation to minimum temperature forecasting. W. C. JACOBS. *Monthly Weather Rev.*, **67,** *pp.* 439–443, *Dec.*, 1939.—Brunt has calculated that the net loss of heat by radiation from the ground, R_n, is given by $R_n = \kappa_1\rho_1c_1\ (\delta T/\delta z)_z = 0$ where $\kappa_1\rho_1c_1$ are, respectively, the conductivity, density and specific heat, of the soil whilst T is the temperature and z the depth into the ground measured downwards. This equation is combined with the relation $R_n = \sigma T^4(1 - a - b\sqrt{e})$ and applied to the forecasting of frosts in the Riverside and El Centro fruit-growing districts of California. It is shown that Brunt's formula cannot predict low temperatures more accurately than can the empirical formulae developed for the 2 districts. It is of great use, however, as an additional check on the empirical formulae and some half-dozen items of qualitative information which may be drawn from it are listed. G. C. McV.

2083. Convergence and divergence in the atmosphere. C. S. DURST. *Roy. Meteorolog. Soc., J.*, **66,** *pp.* 171–179, *April*, 1940.—The departure of the actual wind from the geostrophic wind is defined as the ageostrophic wind. The magnitudes of the ageostrophic winds as measured from pilot balloon ascents are examined and found to be in many cases greater than can be explained by the probable errors of measurement. A method is developed of calculating the ageostrophic winds from the measurements of the geostrophic winds and of obtaining the convergence due to these ageostrophic winds. A case is examined in detail and the convergence is calculated. It is shown that in a region where pressure was falling there was strong convergence near the surface and strong divergence at a level of 5 km. [See Abstract 3613 (1938).] AUTHOR.

2084. Evaporation loss per month from 2 drainage areas. D. LLOYD. *Roy. Meterolog. Soc., J.*, **66,** *pp.* 181–193, *April*, 1940.—Monthly data of the apparent loss by evaporation, etc. of moisture from Vyrnwy and Rivington drainage areas are examined in relation to the rainfall and the temperature. After discussing the subject matter, the association and the degree of association are determined on the hypothesis that variations in evaporation loss can be associated with the variations in rainfall and temperature in a joint functional manner. The regressions have been computed together with the formal evaluation of the significance of the statistics. The results show that, when the temperature is constant, the evaporation loss is proportional to the rainfall; when the rainfall has a given value, the loss increases in relation to the temperature; while the loss is reduced according to the previous rainfall. There is similarity in the relations at Vyrnwy and Rivington. AUTHOR.

2085. Theoretical aspects of size distribution of fog particles. T. E. W. SCHUMANN. *Roy. Meteorolog. Soc., J.*, **66,** *pp.* 195–207, *April*, 1940.—Following some very interesting work by Houghton and Radford on the determination of size distribution of drops in fogs and clouds, a theory is here presented to account for the experimental results obtained. The basis of the theory is that, due to Brownian movement, to turbulence and to the different rates of falls of drops of various sizes under the influence of gravity, collisions between the drops take place and that upon collision

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coalescence results. There will thus be a gradual increase in the average size of the drops constituting the fog due to these collisions, and the problem with which one is confronted is to determine what the resultant size distribution of the drops will be. In a simple case, where it is assumed that the frequency of collision is independent of the size of drops, it has been found possible to arrive at a mathematical expression for the "volume distribution curve". The result thus obtained shows very satisfactory agreement with the experimental values given by Houghton and Radford. It has also been found possible to obtain an approximate theoretical value for the rate of growth of the " most preferred " drop sizes, but it would appear that in nature the rate of growth is several times more rapid than the theoretical value. The theory might prove useful in showing how research should be directed in order to arrive at a full understanding of the mechanism by which fogs and clouds are formed. AUTHOR.

2086. Atmospheric pollution in Dublin in 1939. A. G. G. LEONARD, B. P. MCVERRY AND D. CROWLEY. *Roy. Dublin Soc., Proc.*, **22**, 25, *pp*. 257–265, *May*, 1940.—This paper continues previous work [see Abstract 2450 (1939)]. A second set of apparatus has been installed at Albert Farm, Glasnevin, for purposes of comparison. Graphs are drawn indicating the variation of both soluble and insoluble solids deposited at the two stations throughout the year. Comparison is also made graphically between the mean monthly shade due to suspended impurity and the measurement of SO_2 absorbed by PbO_2 in Dublin, and an equation connecting the two established. This equation is applied to the Albert Farm results. Comparison of sunlight at the two stations as measured by the liberation of iodine from KI reveals in general a higher value at Albert Farm. The relationship between deaths from respiratory diseases and pollution by suspended matter is next dealt with, curves showing the variation of each in Dublin for the period 1938-1940. A. E. M. G.

See also Abstract

1270B. Calculation of illumination from sun and sky. E. Elvegård and G. Sjöstedt.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

2087. Influence of localized space charges on measurement of atmospheric electric field. E. MEDI. *Ricerca Scientifica*, **11**, *pp*. 128–132, *March*, 1940.—It is possible to discover and locate localized space charges in the atmosphere by means of simultaneous measurements of the atmospheric electric field in neighbourhood of conducting walls in different positions. L. E. F.

2088. Method of plotting electron distribution curves for the F-layer. C. W. MCLEISH. *Canad. J. of Research, A*, **18**, *pp*. 98–103, *May*, 1940.—A method of analysis of a (P', f) record is described, which enables one to plot the electron density of the F-layer of the ionosphere with respect to height above its lower boundary. AUTHOR.

RADIOACTIVITY.

2089. Slowing down of heavy ions by matter. Application to the rupture of U. P. Havas. *J. de Physique et le Radium,* **1,** *pp.* 146–154, *April,* 1940.—A theoretical discussion of the passage of heavy ions through matter is given, taking as a particular case the Br and La products of U rupture. It is pointed out that these ions have lost many electrons; that when an electron is captured the probability of loss again is much smaller than for α-particles and, consequently, this gives rise to considerable straggling. The cases of both radiative and non-radiative capture of electrons is dealt with. It is shown that with heavy ions, in contrast to α-particles, the radiative process should be capable of detection as the transition to the 1*s* state has a probability of the same order of magnitude as that of the non-radiative process. Again, in contrast to α-particles, it is shown that the density of ionization along the path of a heavy ion falls off toward the end of the path in agreement with experiment. W. E. D.

2090. Energy release from $Be^9(d,\alpha)Li^7$ and production of Li^{7*}. E. R. Graves. *Phys. Rev.,* **57,** *pp.* 855–862, *May* 15, 1940.—The α-particles from $Be^9(d,\alpha)Li^7$ have been investigated with a variable air-pressure absorption cell, ionization chamber and linear amplifier. It has been established that there are **2** groups of α-particles differing at 760 mm. pressure and 15°C. by $3 \cdot 08 \pm 0 \cdot 10$ mm. range reduced to zero bombarding voltage. The groups have been shown to be associated with the production of Li^7 in the ground state and in an excited state. At 239 kV bombarding voltage, the excited state is formed 1·7 times as often as the ground state. The energy balance, Q, associated with the production of the ground state has been determined to be $7 \cdot 093 \pm 0 \cdot 022$ eMV. The energy of the excited level has been determined to be 494 ± 16 ekV. The total yield curve for α-particles has been investigated from 235 kV to 390 kV bombarding voltage. The measured value for the energy of the excited level in Li^7 is discussed in connection with values from other reactions in which Li^7 is an end product and with γ-ray measurements of the level. Author.

2091. Oppenheimer-Phillips process. G. M. Volkoff. *Phys. Rev.,* **57,** *pp.* 866–876, *May* 15, 1940.—A critical study of the previous theoretical treatments of the process of neutron capture by heavy nuclei bombarded with deuterons shows that, while the dependence of the transmutation function on the incident deuteron energy, W, has been given correctly, the energy distribution of the outgoing protons has not been satisfactorily estimated. The application to the Oppenheimer-Phillips process of the usual formula for the cross-section is shown to be justified for restricted values of the atomic number Z and of the deuteron energy. Bethe's method is used to express the partial cross-section as a product of **3** factors: the penetrability of the potential barrier, the sticking probability of the neutron and the energy transfer factor. Methods of obtaining the deuteron wave-function are discussed. Calculations of the transmutation function are extended to higher values of Z and W, and results obtained by using the O-P-Bethe and the Kapur methods are compared. The proton energy distribution is discussed. A re-evaluation of the dependence of the transfer factor on the proton energy, K, leads to a result differing from Bethe's. The transfer factor is found to have a fairly sharp maximum, and to determine essentially the proton energy distribution. For high Z and low W the position and half-breadth of this maximum is given roughly by $K_0 \sim W$ and $\Delta K_0 \sim 3\cdot 3\, WZ^{-\frac{1}{3}}$. Lifshitz' and Kapur's treatments of proton energies are examined and found to be unsatisfactory. AUTHOR.

2092. Products of U fission, radioactive isotopes of I and Xe. R. W. DODSON AND R. D. FOWLER. *Phys. Rev.*, **57**, *pp.* 966–971, *June* 1, 1940.—Radioactive iodines have been further studied with results which, in addition to confirming those of previous investigators, establish the following active substances as products of the fission of U: I$>^{131}$ 6·6 hr. → Xe$>^{131}$ 9·5 hr. → Cs (?). Xe$>^{131}$ 4·3 day → Cs. (?). The 4·3 day Xe is produced by the decay of the 22 hr. I. The 6·6 hr. I is either a direct fission product, or the daughter of an active Te of half-life less than 1 min. AUTHORS.

2093. Radioactive isotopes of In. J. L. LAWSON AND J. M. CORK. *Phys. Rev.*, **57**, *pp.* 982–994, *June* 1, 1940.—It is shown that radioactive isotopes of In may be formed possessing 10 distinct half-lives ranging from 13 sec. to 50 days. By producing the various isotopes with different methods of excitation and measuring the energies of the β- and γ-radiations emitted by each it now becomes possible to assign with reasonable certainty each radioactivity to an isotope of a particular mass number. Energy level diagrams can be constructed for certain of the excited nuclei. Increased resolution of the magnetic β-ray spectrometer now makes it possible to identify positively the element in which internally converted γ-rays are emitted. This is accomplished by observing the differences in the K-, L- and M-conversion electron energies and comparing with known binding energies obtained from X-ray analysis. The total conversion coefficients are observed in several cases, and the ratios of K- to L-conversion coefficients for individual γ-rays are used to compute the probable energy level spin values on the basis of present theory. A radioactivity of 50-day half-life assigned to In ^{114} is shown to consist of a γ-ray emission followed by a β-ray of half-life 72 sec. and energy 1·98 eMV. It thus becomes possible to observe the form of this β-spectrum in the magnetic spectrometer, and since it is an allowed transition it is significant to compare it with the present theory of β-decay which has been developed only for transitions of this type and until now always tested by measurements on forbidden spectra. Within the probable errors the experimental results conform with the theoretical predictions of the Fermi theory. [See Abstract 3976 (1939).] AUTHORS.

2094. Resonance effects for α-bombardment of Al nuclei. O. MEERHAUT. *Zeits. f. Physik*, **115**, 1–2, *pp.* 77–96, 1940.—By means of the photographic plate an investigation is made of the protons which are emitted by Al on α-bombardment. Four resonance levels of an average width of 300 000 to 400 000 eV are found in agreement with Chadwick and Constable. The range of the emitted proton groups is given together with the energies of the transmutation. L. K.

2095. β-Radiation of RaA and formation of element 85. W. MINDER. *Helv. Phys. Acta*, **13**, 2, *pp.* 144–152, 1940. *In German.*—Measurements were made of the increase of β-radiation from Ra emanation and its decay products for a period of 13 min. This rise was found to be initially appreciably faster than the theory of the formation of RaB + RaC demands. The excess can be simply explained by a weak β-radiation from RaA. This radiation would be almost completely suppressed by material equivalent to 1 mm. of air. Apart from this component the rise of β-radiation follows very closely the requirements of theory. A β-derivative of RaA leads to the hitherto unknown element 85, to which the name " helvetium " (Hv) is assigned. Chemical reactions have up to now failed to show the existence of this element. The investigation is being continued. A. W.

2096. Internal scattering of γ-rays. E. P. Cooper and P. Morrison. *Phys. Rev.*, **57,** *pp.* 862–866, *May* 15, 1940.—If an element is irradiated with γ-rays of sufficiently high energy, the upper limit of the Compton recoils is less than the minimum energy of photo- or conversion electrons from any shell. But electrons of energy between these two limits may be ejected in processes in which the momentum condition can be relaxed. Such processes are (1) the scattering of an external γ-ray by a bound electron, where momentum can be taken up by the nucleus, (2) the internal scattering by the electrons of the radioactive atom itself, where the radiation field of the near-by nucleus can fulfil momentum conditions impossible for a plane wave. The authors consider the second case, for scattering of an electric dipole γ-ray by *s* electrons. Dirac electron theory is used with Born approximation. The process is of order α compared to the internal conversion, as expected. The small result indicates that most of the electrons observed in such a region, e.g. from the 2·62 eMV γ-ray of Th C″—are of instrumental origin. This is in agreement with the results of the latest experiments. Authors.

***2097. Apparatus for viewing and measuring stereoscopic cloud-chamber photographs.** C. C. Jones and A. Ruark. *Am. Phil. Soc., Proc.*, **82,** 3, *pp.* 253–274, 1940.—Projecting apparatus is described which makes it possible to obtain quick and accurate measurements of helical electron tracks formed in a deep cloud chamber and to get undistorted full-sized stereoscopic views of the tracks. All measurements are made with the aid of a ground-glass screen mounted on sliding ways. The observer sits in a comfortable position so that muscular strain is reduced, and optical strain is also reduced, for the eyes work at normal convergence and accommodation. Accessories useful in measurement are described. A mechanical method is given for eliminating important troubles due to shrinkage of the film and displacement of the film during reprojection. Since images on the screen are conical projections of real aerial track images, formulae are derived for correcting the apparent radii and axial dimensions of helical tracks; tests on wire models confirm their validity within 1%. A conservative statement of the performance of the instrument is that, for tracks of about 5 cm. radius, unaffected by multiple scattering, radii can be obtained within 2% and scattering angles to better than 1°. Authors.

***2098. Geiger-counter amplifier with high resolving power.** F. Goos and O. Ehmann. *Phys. Zeits.*, **41,** *pp.* 107–109, *March* 1, 1940.—The Neher-Harper circuit is used for the amplification of the current from coincidence counters. The high voltage is directly connected with the amplifying valve, a screened-grid valve of the normal type. Details of the arrangement and adjustment are given. The resolving power could be increased to $1 \cdot 2 \times 10^{-6}$ sec. for double coincidences. [See Abstracts 3804 (1936) and 5480 (1937).] L. K.

***2099. Ionization measurements of radiations from radioactive substances.** C. G. Montgomery and D. D. Montgomery. *Frank. Inst., J.*, **229,** *pp.* 585–611, *May*, 1940.—A comprehensive survey is given of the methods available for measuring the ionization produced by radiations from radioactive substances. Firstly, typical circuits are discussed for measuring the current in an ionization chamber, and a suitable method of constructing seals for high-pressure chambers is described. It is remarked that the recombination of ions is dependent on the pressure of the gas, the field between the electrodes and the nature of the ionizing radiation; detailed consideration is next given to the relative value of various instruments, used in conjunction with the ionization chamber, for detecting, respectively, α-particles, β-particles and γ-rays. The instruments dealt with are gold-leaf, single-fibre and double-fibre electroscopes, Lindemann and quadrant electrometers, and 2 types of electrometer triodes (FP54 and RCA38) connected to a high-resistance galvanometer. The sensitivities are compared for the 3 types of radiations and, in the case of β-rays and γ-rays, consideration is given to the cases where the lower limit to the amount of radiation detected per second is conditioned by fluctuations of various kinds. Finally, the relative sensitivity of Geiger counters and ionization chambers is discussed, and an expression is derived which indicates the relative importance of the various phenomena which limit the number of β-rays or γ-rays which can be detected by very small ionization chambers. W. E. D.

***2100. Application of method of coincidence counting to experiments in nuclear physics.** J. V. Dunworth. *Rev. Sci. Instruments*, **11,** *pp.* 167–180, *May*, 1940.—The paper describes the principles involved in the application of coincidence counting to problems in nuclear physics and gives details of the various methods of approach to the solution of nuclear level schemes, with some of the difficulties encountered. It is shown that the maximum source strength which can be used is inversely proportional to the coincidence resolving time and that the method of experiment has the great advantage over most other methods in that it can be used with very weak sources (sources having an activity of about 10^{-5} millicurie). An accurate knowledge of the absolute net efficiency of a Geiger counter for all types of radiation is required in the interpretation of the coincidence rates, and the method of achieving this at the same time as information is obtained about nuclear level schemes is explained. Further, it is pointed out that the method makes possible a simple and rapid determination of the total energy of disintegration of β-radioactive nuclei and therefore of the mass differences between parent and daughter nuclei. Author.

***2101. Composition of mixed vapours in cloud chamber.** T. N. Gautier and A. E. Ruark. *Phys. Rev.*, **57,** *pp.* 1040–1041, *June* 1, 1940.—The composition of the alcohol-water vapours commonly used in cloud chambers differs from that of the liquid mixtures from which they are produced. This must be considered when ranges of cross-sections are to be calculated. Curves are presented for the case of ethanol and water showing, for various temperatures, the vapour pressure of each constituent as a function of the percent volume of alcohol in the liquid. Attention is called to errors incurred if the cycle of operation is so brief that the vapours do not come up to equilibrium concentration between expansions. Authors.

See also Abstracts **1962, 2081, 2259.**

RADIATION.

ABSORPTION.

2102. Origin of colour in paramagnetic salts and solutions. D. M. Bose. *Indian Journ. Phys.*, **13**, [18 *pp.*], 1939.—A review of the results and theories at present available. W. R. A.

2103. Mechanism of long wavelength absorption of carbonyl group. H. L. McMurry and R. S. Mulliken. *Nat. Acad. Sci., Proc.*, **26**, *pp.* 312–317, *April*, 1940.—The explanation of the production of *K* spectra of compounds with a conjugated system of double bonds on the basis of molecular and atomic orbitals is considered. When C=O or C=S are also present in the system a much weaker *R* spectrum occurs at longer wavelengths than the *K* spectrum. In saturated aldehydes and ketones the maximum of this weak absorption is near 2 900 Å. The *R* spectrum is probably due to a forbidden transition. Absorption by aldehydes and ketones in the 1 800 Å region is due to a permitted transition. The loosely-bound pair of non-bonding electrons present in the O atom of the C=O group, and not present in the ethylenic linkage is responsible for the absorptions at 2 900 and 1 800 Å. In the C=S group the non-bonding pair is more loosely bound, so that absorption is here shifted toward even longer wavelengths. A. J. M.

COLORIMETRY.

2104. Hue sensibility to dominant wavelength change and relation between saturation and colorimetric purity. D. Nickerson and W. C. Granville. *J.O.S.A.*, **30**, *pp.* 159–162, *April*, 1940.—Measurements of dominant wavelength and colorimetric purity have been made on 2 sets of Munsell papers, one set consisting of 100 papers at constant lightness and saturation, the other consisting of 50 hues at maximum saturation for pigment colours. From the data obtained curves have been plotted to show (*a*) the wavelength difference corresponding to constant (not liminal) Munsell hue difference throughout the spectrum and (*b*) colorimetric purity as a function of dominant wavelength, both for a moderate level of saturation and for a liminal (threshold) degree of saturation. J. W. T. W.

EMISSION.

***2105. Development of water-cooled quartz mercury lamps.** E. B. Noel. *J. of Applied Physics*, **11**, *pp.* 325–336, *May*, 1940.—From the Cooper-Hewitt mercury lamp of 1902, operating at a pressure of 0·0003 atm. and an efficiency of 18 lumens/W, lamps in hard glass and in fused quartz have been developed with pressures up to 200 atm. and efficiencies of 40 lumens/ W and above. At the highest pressures water-cooling is required, and a careful co-ordination of the designs of lamp, jacket and ballast, is required for successful operation. Brightness-distribution and spectral-energy data are given for the A-H6 and 2 experimental water-cooled lamps. Photo-engraving, television and searchlight applications, of the A-H6 water-cooled lamp are discussed. Author.

2106. Temperature radiation of the Hg high-pressure arc in the far infra-red (300 μ). W. Dahlke. *Zeits. f. Physik*, **115**, 1–2, *pp.* 1–10, 1940.—The 300 μ emission of the Hg high-pressure arc can be represented as the radiation of a grey body under the assumption of local thermodynamic equilibrium. An equation is derived for the emission as function of the wavelength, the energy of the discharge, the vapour pressure and cross-section of the discharge. Qualitative and partly quantitative agreement with experiment is obtained. L. K.

2107. Seasonal and atmospheric temperature effect in cosmic radiation. V. F. Hess. *Phys. Rev.*, **57**, *pp.* 781–785, *May* 1, 1940.—By analysis of the observations of cosmic-ray ionization on the Hafelekar (2 300 m. above sea level, 48° N. geomagnetic lat.) during 5 years the existence of a seasonal variation with an amplitude of $\pm 0{\cdot}9\%$ has been proved. Reduction of the monthly means to the annual mean temperature diminishes the amplitude of the 12-month wave to one-half without eliminating it. This agrees with Vallarta and Godart's interpretation of the seasonal effect. A very marked seasonal change in the temperature coefficient of the cosmic radiation has been found, recurring every year. In winter the coefficients are about $-0{\cdot}12$, in summer $-0{\cdot}055\%$/deg.C. The correlation between temperature and ionization is in winter twice as great as in summer. Derivation of the temperature coefficient from hourly observations gives too low absolute values because of the diurnal changes involved. With unscreened ionization chambers and also with coincidence counter arrangements (triangle position), smaller temperature coefficients are found, which become positive in summer. It is thus not possible to explain the normal negative temperature effect of cosmic radiation completely on the basis of the mesotron disintegration hypothesis. Author.

2108. Penetrating radiation of more than 300 m. water-equivalent. J. Barnóthy. *Zeits. f. Physik*, **115**, 3–4, *pp.* 140–149, 1940.—The results of observations of cosmic rays in great depths and of rays of horizontal incidence at sea level are discussed. The intensity decreases with the 2·6th power of the depth; a strong decrease of the intensity with thin Pb-filters and subsequent increase with thicker filters has been observed. These properties of the radiation can be explained if the radiation in great depths and the horizontal component at sea level, respectively, consists of neutrons or neutrinos which are produced by the disintegration of mesons. L. K.

2109. Hard component of cosmic radiation in stratosphere. A. Ehmert. *Zeits. f. Physik*, **115**, 5–6, *pp.* 326–332, 1940.—The number of penetrating rays has been measured up to an atmospheric pressure of 16 mm. Hg in a balloon instrument which contained a 9 cm. layer of Pb between 3 counters. The counters were arranged one above the other. The measurements agree up to 300 mm. Hg with the extrapolated absorption curve measured at lower levels in air. Below 300 mm. the number of coincidences increases further down to 100 mm. Hg, remains constant between 100 and 16 mm. Hg within the limits of accuracy (10%), and has a 12·2 times greater value at 16 mm. Hg than at sea level. [See following Abstract.] L. K.

2110. Disintegration probability of the meson. A. Ehmert. *Zeits. f. Physik*, **115**, 5–6, *pp.* 333–338, 1940.—The author uses his observations [see preceding Abstract] of the increase of particles penetrating 9 cm. Pb with the height in the lower atmosphere together with the absorption of cosmic rays in water and Blackett's data of the impulse spectrum of the particles to calculate the mean lifetime of the meson. No further assumptions on the height of origin of the meson, the original energy distribution and the loss of energy, are necessary. The expression obtained is: $\mu c^2/\tau =$

$(2\cdot 1 \pm 0\cdot 6)10^{13}$ eV/sec., where $\mu = 160 \times$ mass of the electron, $\tau = (3\cdot 7 \times 1)\ 10^{-6}$ sec., i.e. slightly above Euler and Heisenberg's value. Other determinations of τ from the barometer effect lead to approximately equal values, contrary to previous interpretations if the particle energy is taken into consideration in a way appropriate to these measurements. L. K.

2111. Intensity and rate of production of mesotrons in the stratosphere. M. Schein, W. P. Jesse and E. O. Wollan. *Phys. Rev.*, **57**, *pp*. 847–854, *May* 15, 1940.—Two free balloon flights have been made with a coincidence-counter apparatus designed to record the vertical mesotron intensity and also the number of mesotrons produced in a 2-cm. lead block by a non-ionizing radiation. The results show that the mesotron intensity at first increases with elevation and reaches a maximum at a pressure at about 6·6 cm. Hg where the intensity is about 11 times that at sea level. Above this altitude the intensity falls off until at the lowest pressure reached (3·6 cm. Hg) the intensity has decreased to about 8 times the sea-level value. Between $p = 8$ cm. and 50 cm. Hg the mesotron intensity decreases almost exponentially with the mass of air traversed from which is obtained a constant " absorption coefficient" $\mu = 1\cdot 2 \times 10^{-3}$ gm.$^{-1}$ cm^{-2}. for the mesotrons in this range. The production of mesotrons in the lead block becomes noticeable at about 35 cm. pressure and increases with altitude at about the same rate as does the soft component. This is evidence that the photons are the agents responsible for a large part of the observed creation in the lead, and on this assumption the authors calculate a cross section for the creation process $\sigma_{ph} = 0\cdot 7 \times 10^{-27}$ cm^{-2}. per nuclear particle in lead.

2112. Anomalous absorption of hard component of cosmic rays in air. M. Ageno, G. Bernardini, N. B. Cacciapuoti, B. Ferretti and G. C. Wick. *Phys. Rev.*, **57**, *pp*. 945–950, *June* 1, 1940.—The anomalously large absorption of mesotrons in air has been confirmed by a comparison of the vertical intensity of mesotrons at 2 different altitudes (500 m. and 3 460 m). At 3 460 m. the vertical intensity has also been compared with the intensity under a zenith angle of 45°. If the results obtained are interpreted according to the hypothesis of the instability of the mesotron, they are found to be consistent with the assumption of a proper lifetime of 4 or 5 μsec. for the mesotron. Authors.

See also Abstracts 2128, 2148.

FLUORESCENCE AND PHOSPHORESCENCE. LUMINESCENCE AND AFTER-GLOW.

2113. The luminescence of crystalline phosphors. N. Riehl and M. Schön. *Zeits. f. Physik*, **114**, 11–12, *pp*. 682–704, 1939.—The electron theory of solids is used to interpret the phenomena of phosphorescence and luminescence in crystalline phosphors. It is assumed that the activating atoms in phosphors give rise to discreet " perturbation terms " which are occupied in the unexcited state and lie near and slightly below an occupied zone in the crystal. In order to explain the storing up of energy (phosphorescence), a second assumption is made, namely, that metastable " collecting " terms exist in the neighbourhood of an unoccupied zone. The electrons which have reached the unoccupied zone, pass into the " collecting " level where they are stored until thermal motion or infra-red irradiation lifts them into the next zone. These assumptions suffice to explain nearly all phenomena observed in crystalline phosphors, such as the quenching effect. the difference between spontaneous luminescence and phosphorescence, the relations between temperature, intensity, wavelengths and the emission spectrum, etc. [See Abstracts 4472 (1937) and 1149 (1939).] L. K.

2114. Photo-electric properties of decomposed ZnS-phosphors, activated by Cu. F. Goos. *Ann. d. Physik*, **37**, 1, *pp*. 76–88, *Jan.*, 1940.—Two effects are to be distinguished in a ZnS. Cu phosphor under the influence of α-rays: the red-effect of the primary photo-electric current and the quenching effect of phosphorescence which is measured by means of the dielectric constant. A method is described which furnishes reproducible results by exposing the crystal alternatingly to blue light, red light, white light, and changing the polarity of the field. The maximum effect of radiation which takes place in the blue region for the ZnS crystal and the phosphor occurs for the decomposed phosphor in the long-wave spectral region (up to 10 000 Å) as well. The red-effect is represented by the rate in the change of the current for a transition from red to blue light. The red-effect increases with the degree of decomposition, in a similar manner to the quenching effect for long waves. The quenching effect depends on the phosphorescence properties of the crystal, contrary to the red-effect. [See Abstract 1147 (1939).] L. K.

2115. Photoluminescence of electrolytic solutions. Part I. B. Gordon and A. Shishlovsky. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp*. 91–95, 1939. *In Ukrainian.*—Experiments on salts of Tl^{+} Pb^{++} UO_2^{++} and Cu^{++} in water and alcohol solutions show that where the formation of a complex should be expected, corresponding to formation of a protective layer round the cation, the solution is usually photoluminescent. D. S.

INTERFERENCE, DIFFRACTION AND SCATTERING.

2116. Fresnel formulae applied to non-reflecting films. K. B. Blodgett. *Phys. Rev.*, **57**, *pp*. 921–924, *May* 15, 1940.—The Fresnel formulae are applied to the calculations of the amplitudes of rays reflected and transmitted by non-reflecting films of transparent isotropic substances. Two cases are considered. In the first the film of refractive index n_0 is bounded on both sides by a medium of refractive index n_0. In the second the film is bounded by media of refractive indices n_0 and n_2. It is shown how in the first case these formulae lead to zero reflection when the thickness t of the film is given by $n_1 t \cos r_1 = (2n + 2)\lambda/4$. In the second case for zero reflection the thickness must be given by $n_1 t \cos r_1 = (2n + 1)\lambda/4$. [See Abstract 1627 (1939) and following Abstract.] Author.

2117. New method for investigating refractive index and thickness of thin interference films on glass. A. Vašiček. *Phys. Rev.*, **57**, *pp*. 925–931, *May* 15, 1940.—If plane polarized light falls on lead glass, the surface of which had been chemically changed to be covered with an interference film, the reflected light is in general elliptically polarized. If, however, the path difference of reflected rays from the air-film boundary and from the film-glass boundary is $2n_0 d \cos r + \frac{1}{2}\lambda = k\lambda$, where k gives the order of the maximum, the first maximum for $k = 1$ being $d(n_0^2 - \sin^2 \phi)^{\frac{1}{2}} = \frac{1}{4}\lambda$, and where n_0 is the refractive index of the film, d its thickness, ϕ the angle of incidence, r the angle of refraction, and λ the wavelength of the monochromatic light, then the reflected light is plane polarized. For this angle of incidence, ϕ, the plane of polarization of the reflected plane-polarized light will be the same as if the polarized light were reflected from an ideal surface of glass (not covered with a film). From the angle between the plane of polarization of the analyser and the plane of incidence the refractive index of the glass, n, can be calculated according to the formula deduced from Fresnel's relations: $n^2 = \sin^2\phi[1 + \tan^2\phi \tan^2(\psi + 45°)]$, where ϕ is the angle of incidence, ψ the angle between the plane of polarization of the analyser and the plane of incidence (the angle between the plane of polarization of the polarizer and the plane of incidence is 135°). The refractive index, n_0, and thickness, d, of the surface film can be calculated from the formula for the maxima if 2 angles of incidence, ϕ_1 and ϕ_2, are determined for 2 different wavelengths. The refractive index of the film, n_0, is given by the formula: $n_0 = \{(\lambda_1^2 \sin^2\phi_2 - \lambda_2 \sin^2\phi_1)(\lambda_1^2 - \lambda_2^2)\}^{\frac{1}{2}}$. The results of the measurements are given in tables. [See Abstract 1956 (1939) and preceding Abstract.] AUTHOR.

2118. Theory of Plotnikow effect. T. NEUGEBAUER. *Phys. Zeits.*, **41,** *pp.* 55–62, *Feb.* 15, 1940.—A theory has been worked out to explain the Plotnikow effect [see Abstract 3103 (1930)]. The theory makes use of the fact that small groups of parallel chain molecules are optically anisotropic for infra-red light. The optical birefringence is calculated, and the refraction and total reflection occurring at the boundaries between 2 molecular groups are given. The observed small deviations from the rectilinear propagation of light are explained in this way, and the theoretically calculated value is found to be of the right order of magnitude. It is shown that the Plotnikow effect is not a particular case of the Rayleigh scattering of light. L. K.

2119. Theory of light scattering. R. S. KRISHNAN. *Phil. Mag.*, **29,** *pp.* 515–516, *May*, 1940.—The author points out the misuse and misquotation of experimental conditions used by himself [Abstracts 3851 and 4781 (1935)] in a paper by S. Parthasarathy [Abstract 751 (1940)]. C. B. A.

See also Abstract 2048.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

2120. Photochemical oxidation of oxalic acid. R. LIVINGSTON. *J. Phys. Chem.*, **44,** *pp.* 601–611, *May*, 1940.—Previous work [see Abstract 1446 (1932)] on the photolysis of ferric oxalate by monochromatic light at room temperature is confirmed quantitatively. The corresponding iron-sensitized oxidation is shown to have a quantum yield of approximately unity, twice as great as the yield of the photolysis. These results are checked by an independent experimental method. It is shown that the absorption of red light by the system does not induce the reaction. A series of semi-quantitative experiments, performed in the dark, demonstrated that the thermal oxidation of ferrous ion by O_2 does not induce the oxidation of oxalate ion. A brief discussion of the more probable mechanisms is included. AUTHOR.

***2121. Apparatus for study of photochemistry of sheet materials.** H. F. LAUNER. *Bureau of Standards, J. of Research*, **24,** *pp.* 567–577, *May*, 1940.—An apparatus is described for the study of the photochemistry of organic materials (e.g. paper, cellulose acetate, sheet rubber) in sheet form. Particular attention has been paid to the elimination of concurrent temperature effects, by (*i*) maintaining the sheet in intimate contact with a thermostated Al backing, and (*ii*) removing the infra-red radiation by means of a $CuCl_2$ filter of special design. The importance of controlling the moisture and O_2 content of the surrounding atmosphere is also discussed. S. J. G.

2122. Lifetime of active polymeric molecules. T. T. JONES AND H. W. MELVILLE. *Roy. Soc., Proc. A*, **175,** *pp.* 392–409, *June* 12, 1940.—A method of determining the distance of diffusion in space of a polymer reaction is described. It depends upon the fact that in a reaction—the direct photo-polymerization of methyl acrylate—in which active molecules mutually destroy each other, this mutual interference may be demonstrated by using 2 sources of photo-excitation. The velocity of polymerization then depends on the distance between the 2 sources. The exact theory of the method has been worked out for H atoms. The results obtained from this investigation are applied to the methyl acrylate reaction. This result is then further employed along with previous data to compute the absolute value of the reaction velocity coefficient between active polymer molecules and monomer. AUTHORS.

2123. Increase of chemical activity of CdI_2 by irradiation. J. A. HEDVALL, P. WALLGREN AND S. MÅNSSON. *Faraday Soc., Trans.*, **36**, *pp.* 697–706, *June*, 1940.—A short survey is given of the different kinds of faulty structure in crystal lattices, of the conditions for the production of irreversible irregularities or for the existence of the reversible ones in general, and of the importance of imperfectly formed crystals for different branches of chemistry. It is shown that increased chemical activity is caused not only by disturbance of crystallographic symmetry, but also by changes of the magnetic or the electric state of the lattice. In accordance herewith photochemical effects have been found involving increased surface activity with respect also to the chemical interchange with surrounding materials. Arising from these experiments the existence of crystals was assumed, the photosensitivity of which may vary with the kind of crystal faces. It was suggested that this might be the case with crystals built up as layer lattices. Experiments carried out with Cd halides have, indeed, shown that the prism faces of CdI_2 are especially sensitive, whereas the basal faces are left unattacked by absorbable wavelengths. The photochemical process requires small quantities of water adsorbed at the surface and, consequently, it can be more or less completely prevented by compounds which are more intensely adsorbed than water. A smaller effect of the same kind has been found when using that modification of $CdBr_2$ which is of the same type (C : 6) as CdI_2. No visible action of radiation could be observed with $CdCl_2$ and CdF_2, the lattices of which are more different from the type of CdI_2. It has also been shown that the surface activity, caused by the photochemical process, involves increased rate of reaction of such parts of crystals; thus the prism faces of CdI_2, when irradiated by absorbable wavelengths, are more rapidly attacked by a solvent than in darkness or if radiated by light not being absorbable. AUTHORS.

2124. Connection between the internal and external exposure in photographic layers. E. GRETENER. *Zeits. f. wiss. Phot.*, **38**, *pp.* 248–286, *Nov.–Dec.*, 1939.—Hitherto investigators in this subject have been content to consider a 1- or 2-dimensional distribution of light, but the author gives a study, theoretical and mathematical, of the deeper actions in the emulsion layer. J. J. S.

***2125. Halogen-silver films from hydrate cellulose. Part II.** E. ELVEGÅRD AND G. SJÖSTEDT. *Zeits. f. wiss. Phot.*, **38**, *pp.* 229–247, *Nov.–Dec.*, 1939.—Having given, in a previous paper [see Abstract 444 (1940)], an account of the production of photographic halogen-silver emulsions in leaves from hydrate cellulose as dispersion medium the authors in the present paper deal with the following: (1) Various characteristics of hydrate-cellulose which through the production of silver-halogenide in its interior has been made sensitive to light; a developer is described which is suitable for the production of these films; (2) the process of fixation of the film is discussed further, and a short account of a suitable fixation bath is given which contains sodium thiosulphate and a rhodar salt; (3) the general characteristics of hydrate-cellulose films are described. J. J. S.

2126. Photochemical sensitization. M. Bodenstein. *Naturwiss.*, **28**, *pp.* 145–152, *March* 8, 1940.—An account of the present position of research on photochemical increase of sensitiveness with historical references from the time of Vogel, who refers to the subject in his handbook on photography in 1802. It seems probable that the difficulties to which the increase of sensibility has led may be solved in the same way as the analogous difficulties in the absorption of CO_2 by plants. In these sensitizing processes 3 stages have to be considered: (1) Light absorption and its result in the sensitizer, (2) carrying over of the energy to the reacting substance, and (3) consequent reactions which this now undergoes.
J. J. S.

2127. Photographic effect of positive rays. H. Lichtblau. *Phys. Zeits.*, **41**, *pp.* 82–86, *Feb.* 15, 1940.—The photographic effect of Mo, Nd, Cp and Hg ions on Ilford Q-plates has been investigated. For Q_3-plates the ionic rays follow the same law as α-rays. The Q_3-plates have a Schwarzschild exponent of 0·99 ± 0·05 for Hg ions. Kinoshita's law does not hold for Q_1-plates which have a finer grain and are less sensitive than Q_3-plates. The photographic effects of light and ions are dissimilar for Q_3-plates but nearly alike for Q_1-plates. L. K.

See also Abstracts **2046, 2047, 2097.**

PHOTOMETRY.

2128. Short wave u.v. radiation measurements by Se blocking-layer photocell. F. Rössler. *Zeits. f. techn. Physik*, **20**, 10, *pp.* 290–294, 1939.—Various processes of practical measurement of short wavelength u.v. radiation with Se blocking-layer cells are discussed and their advantages and disadvantages indicated. The most useful method consists in carrying out differential measurements by means of a prefiltered blocking-layer cell. The spectral sensitivity of such an arrangement is given. G. O. B.

POLARIZATION.

***2129. Simplified half-shadow compensator.** G. Szivessy and W. Herzog. *Zeits. f. Instrumentenk.*, **60**, *pp.* 65–74, *March*, 1940.—An account of a modification of Szivessy's arrangement for measurement of phase differences. It has been used lately for determination of very small transition differences and it has been improved so as to include within its scope not only this but other applications without the necessity of other aids. The principle and practical details relating to the instrument are given, including (1) polarization condition of the waves leaving the compensator plates, (2) characteristics of the compensation azimuth, (3) determination of the angle of ellipticity, (4) intensity of the light transmitted by the analyser. [See also Abstract 1822 (1940).] J. J. S.

REFLECTION, REFRACTION AND DISPERSION.

2130. Dispersion of liquids and solutions. Parts I and II. W. Geffcken and A. Kruis. *Zeits. f. phys. Chem. B*, **45**, 6, *pp.* 411–450, 1940.—A spectrograph is combined with a Rayleigh interferometer in one apparatus so that interferometer chambers and double slit are arranged between the mirror collimator and the prism. The wavelength region from 10 000 to 2 000 Å can be obtained on the plate with one exposure. The apparatus is described in detail ; it allows the measurement of the dispersion of liquids and solids with an accuracy of 10^{-5} for a layer of 1 mm. thickness. The corrections necessary for the elimination of the optical faults of the chambers containing the specimens have been calculated. In Part II experiments carried out on water between 6 680 and 2 120 Å are described. The values of the refractive indices as compared with air are given for 74 wavelengths at 25·00°C. These values are compared with those previously obtained by other authors. [See Abstracts 2873 (1927) and 5543 (1936).] L. K.

See also Abstracts 2048, 2116, 2117, 2230.

SPECTROSCOPY.

2131. Combination frequencies in electronic spectra of rare-earth salts. K. H. HELLWEGE AND A. ROEVER. *Zeits. f. Physik*, **114**, 9–10, *pp.* 564–570, 1939.—The absorption spectra of some rare-earth salts have been observed at the temperature of liquid H_2 [see Abstract 2532 (1939)]. A series of faint lines accompanying an electronic line are interpreted as the superposition of combination frequencies of some lattice vibrations over an electronic transition. The mechanism of the excitation of these combination frequencies by absorption of visible light is discussed. [See following Abstract.] L. K.

2132. Absorption spectrum of Pr salts. A. HELLWEGE. *Ann. d. Physik*, **37**, 3, *pp.* 226–248, *Feb.*, 1940.—The absorption spectra of some crystalline Pr salts have been investigated at the temperature of liquid H_2. The lines were measured with polarized light. The spectra consist of relatively intense sharp lines occurring at intervals of 10-50 cm^{-1}. which are accompanied by groups of numerous lines, close together, at an interval of 60-300 cm^{-1}. from the former lines and faint groups at an interval of 500–1 800 cm^{-1}. The intense lines are attributed to electronic transitions in the $4f$-shell and compared with Bethe's theory. In agreement with Ewald's observations of Nd salts [see Abstract 1205 (1939)] the Pr lines are interpreted as combinations of electronic lines with outer or inner lattice vibrations and their overtones and combination tones [see Abstract 4054 (1939) and preceding Abstract]. The selection rules applying to the electronic transitions break down for increasing frequencies of the lattice vibrations. The observed lattice vibrations agree with the observations made with Nd salts. L. K.

2133. Electric quadrupole moment of the I nucleus. K. MURAKAWA. *Zeits. f. Physik*, **114**, 9–10, *pp.* 651–652, 1939.—The author corrects an error in his previous paper on the quadrupole moment of I [see Abstract 2883 (1938)]. He points out, furthermore, that the discrepancies between his results and those of Tolansky [see Abstract 1661 (1939)] disappear if the term $6p^5\mathrm{P}_1$ is taken to show a splitting of $-0{\cdot}05\ cm^{-1}$. If this value is used, the h.f.s. computed by Tolansky for $sp^5\ {}^3\mathrm{P}_2$ agrees with Murakawa's data and furnishes $-0{\cdot}38 \times 10^{-24}$ for the quadrupole moment from $5s5p^5\ {}^3\mathrm{P}_2$. L. K.

2134. Electric quadrupole moments of Ga^{69} and Ga^{71}. Atomic beam study of the hyperfine structures of the $^2P_{1/2}$ and $^2P_{3/2}$ states of Ga^{69} and Ga^{71}. N. A. RENZETTI. *Phys. Rev.*, **57**, *pp.* 753–765, *May* 1, 1940.—An investigation of the hyperfine structures of the ground $^2\mathrm{P}_{\frac{1}{2}}$ state, and the metastable

$^2P_{3/2}$ state of the 2 isotopes 69 and 71 of Ga has been made with the zero-moment method of atomic beams. Six zero-moment peaks, 3 for each isotope, of the metastable state, and 2, 1 for each isotope, of the ground state have been observed. It has been found that the h.f.s. energy levels for the higher state can be described by an equation of the form $E = aC/2 + bC(C + 1)$, where " a " and " b " are the interval rule and quadrupole interaction constants, respectively.

Ga^{69}: $b/a = 0\cdot0136 \pm 0\cdot0004$ $\quad$ Ga^{71}: $b/a = 0\cdot0068 \pm 0\cdot0004$
$b = (8\cdot69 \pm 0\cdot43) \times 10^{-5}$ cm^{-1}. $\quad$ $b = (5\cdot51 \pm 0\cdot39) \times 10^{-5}$ cm^{-1}.
$a = (6\cdot39 \pm 0\cdot12) \times 10^{-3}$ cm^{-1}. $\quad$ $a = (8\cdot11 \pm 0\cdot11 \times 10^{-3}$ cm^{-1}.

From these the h.f.s. separations are
Ga^{69}: $\Delta\nu = (0\cdot0362 \pm 0\cdot0007)$ cm^{-1}. $\quad$ Ga^{71}: $\Delta\nu = (0\cdot0474 \pm 0\cdot0007)$ cm^{-1}.

and the quadrupole moments are
$Q^{69} = 0\cdot20 \times 10^{-24}$ cm^2. $\quad$ $Q^{71} = 0\cdot13 \times 10^{-24}$ cm^2.

The nuclear spins are verified to be $\frac{3}{2}$. From the zero-moment peaks of the normal state we obtain $\mu_{71}/\mu_{69} = \Delta\nu_{71}/\Delta\nu_{69} = 1\cdot270 \pm 0\cdot006$ and these separations are
Ga^{69}: $\Delta\nu = (0\cdot0897 \pm 0\cdot0011)$ cm^{-1}. $\quad$ Ga^{71}: $\Delta\nu = (0\cdot1139 \pm 0\cdot0019)$ cm^{-1}.
and from these the nuclear moments are $\mu^{69} = 2\cdot11$; $\mu^{71} = 2\cdot69$. AUTHOR.

2135. Radiofrequency spectra of atoms. Hyperfine structure and Zeeman effect in ground state of Li^6, Li^7, K^{39} and K^{41}. P. KUSCH, S. MILLMAN AND I. I. RABI. *Phys. Rev.*, **57**, *pp.* 765–780, *May* 1, 1940.—The molecular beam magnetic resonance method previously used for the study of molecules has been extended to the study of atoms. Transitions between the members of h.f.s. multiplets of the ground state of atoms have been observed directly. In this way the h.f.s. intervals of the normal states of Li^6, Li^7, K^{39} and K^{41} have been measured. Since the measurement of frequency alone is involved, the results are of very high precision. These spectra have been observed in external magnetic fields varying from 0·05 to 4000 gauss, i.e. from the ordinary Zeeman to the complete Paschen-Back region. The lines in the pattern are completely resolved even at the low fields. The h.f.s. separations derived from measurements at different fields are in excellent agreement. Comparison is made between the ratio of the nuclear moments of Li^7 and Li^6 as derived from the h.f.s. measurements with the directly measured ratio. The 2 ratios are 3·9610 and 3·9601, respectively. They agree within the experimental error of 0·04%. The h.f.s. separations are given both in absolute frequency units and in wave numbers.

	sec.$^{-1}$ $\times 10^{-6}$	cm^{-1}.
Li^6	228·22	0·007613
Li^7	803·54	0·026805
K^{39}	461·75	0·015403
K^{41}	254·02	0·008474

AUTHORS.

2136. Hyperfine structure in arc spectrum of Br. S. TOLANSKY AND S. A. TRIVEDI. *Roy. Soc., Proc. A*, **175**, *pp.* 366–382, *June* 12, 1940.—65 classified lines of the Br 1 spectrum, lying in the region 8 650–4 350 Å, have been investigated for hyperfine structure and analysed. It is confirmed that the nuclear mechanical and magnetic moments of both isotopes are the same. No isotope displacement is observed. Hyperfine structure interval factors are derived for 38 terms amongst which are 7 complete multiplet groups. From the hyperfine structure analysis it has been possible to correct some errors in the multiplet analysis. The coupling of the $4p^4$ electron group with the nucleus is shown to be quite large. This group therefore behaves in a manner similar to that of the corresponding $5p^4$ group of iodine. The $4s^2\ 4p^4\ 5s\ {}^4P_{\frac{5}{2}}$ term exhibits deviation from the interval rule, and this accurately obeys the quadratic formula for the interaction which arises when the nucleus has an electrical quadrupole moment. The interaction formula for this term is $E = 223 + \frac{1}{2} \times 47{\cdot}1C + 0{\cdot}17C(C + 1)$ cm^{-1}. $\times 10^{-3}$. AUTHORS.

2137. Orientation of nuclear spins in metals. H. FRÖHLICH AND F. R. N. NABARRO. *Roy. Soc., Proc. A*, **175,** *pp.* 382–391, *June* 12, 1940.—In connection with the possible use of nuclear magnetism for the magnetic cooling method, the behaviour of the nuclear spins of monovalent metals at very low temperature is investigated theoretically. It is shown that, owing to the interaction between the nuclear spins and the conduction electrons, the nuclei of most monovalent metals should become ferromagnetic at temperatures of the order of 10^{-6} degree. The Curie temperature θ for this nuclear ferromagnetism is approximately given by $k\nu\theta \sim 1\epsilon^2/8\zeta$, where ϵ is the hyperfine structure splitting of the free atom and ζ is the energy region occupied by the conduction electrons. Temperatures of this order of magnitude should be attainable by an application of the magnetic cooling method. AUTHORS.

2138. General theory of spectra. Part I. M. H. STONE. *Nat. Acad. Sci., Proc.*, **26,** *pp.* 280–283, *April*, 1940.—A sketch is given of further steps in the direction of a thorough " algebraization " of spectral theory. It is shown that without the mediation of any theory of integration it is possible to define general functions of operators and to elaborate their calculus. A. H.

2139. Determinations of Rydberg constants, e/m and fine structures of H_α and D_α with a reflection echelon. J. W. DRINKWATER, O. RICHARDSON AND W. E. WILLIAMS. *Roy. Soc., Proc. A*, **175,** *p.* 345, *June* 12, 1940. —Corrections to the original [see Abstract 763 (1940)].

2140. Vibration spectra of HN_3, CH_3N_3 and CH_3NCO. Thermodynamic functions of N_3H. E. H. EYSTER AND R. H. GILLETTE. *J. Chem. Phys.*, **8,** *pp.* 369–377, *May*, 1940—The vibration spectra of N_3H, CH_3N_3 and CH_3NCO have been investigated in the spectral region between 2 and 20μ. Correlation of the spectra of these structurally similar molecules has made possible the determination of all the fundamental frequencies of N_3H and all but the methyl torsion frequency in the methyl compounds. From these fundamental frequencies and the known rotational constants the usual thermodynamic functions of N_3H have been calculated to the harmonic oscillator rigid rotator approximation. Equilibrium constants for some characteristic reactions have also been obtained. AUTHORS.

2141. Formation of molecules by collision of 2 particles. Part I. AlH. G. STENVINKEL. *Zeits. f. Physik*, **114,** 9–10, *pp.* 602–619, 1939.—The oven-spectrum of AlH shows that the lines which are missing in the arc spectrum have an enhanced intensity. These anomalies depend on the following factors: (1) The time interval between the beginning of the experiment and the photograph; (2) the temperature in the oven; (3) the pressure in the oven. At a temperature of 2 400°K. and a H pressure of 450 mm. a continuum appears with its maximum intensity in the centre of the 1-1 band. All these effects can be interpreted as consequences of the formation of AlH molecules in the $^1\Pi$ state by collisions of 2 particles. L. K.

2142. Unclassified terms of hydrides. B. GRUNDSTRÖM. *Zeits. f. Physik*, **115**, 3–4, *pp*. 120–139, 1940.—The hitherto unclassified terms of some hydrides, as InH, TlH, HgH, CaH and SrH can be arranged in a dissociation scheme as applications of Mulliken's case " far nuclei, case *c* " and Wigner-Witmer's rule. The ground states of the hydrides are produced by combinations of the ground states of the free atoms. The predissociation occurring in InH and TlH can be obtained with the help of the O^--terms. Further applications of this new scheme of combinations are given. L. K.

2143. Negative bands of heavy nitrogen molecules. R. W. WOOD AND G. H. DIEKE. *J. Chem. Phys.*, **8**, *pp*. 351–361, *May*, 1940.—The so-called negative bands emitted by the N_2^+ molecule have been photographed in the second order of a 21 ft. concave grating with a dispersion of about 0·6 Å per mm. The principal bands of $N^{15} - N^{15}$ and $N^{14} - N^{15}$ are analysed. A comparison of the constants of the 3 isotopic molecules shows that the changes, except for the spin-doubling and perturbations, are well represented by the elementary theory of band spectra. The intensity alterations in the $N^{15} - N^{15}$ bands give $\frac{1}{2}h$ as the value for the nuclear spin of N^{15}. AUTHORS.

2144. Infra-red absorption of HF vapour and its solution in CCl_4. A. M. BUSWELL, R. L. MAYCOCK AND W. H. RODEBUSH. *J. Chem. Phys.*, **8**, *pp*. 362–365, *May*, 1940.—The infra-red absorption of HF has been observed both with the prism and the grating spectrometer. The absorption in the vapour for the single molecules is as previously reported by Imes. At slightly longer wavelengths a very strong absorption band due to the hydrogen bonding in the associated molecules is observed. In solution in CCl_4 the single molecule spectrum undergoes considerable modification and no association is observed. This fact is rather surprising. The infra-red absorption of a thin crystal of KHF_2 was studied in order to fix the frequency of the hydrogen in the FHF^- ion. [See Abstract 459 (1940).] AUTHORS.

2145. U.v. absorption and chemical constitution of substituted ureas and thioureas. A. CLOW AND N. L. HELMRICH. *Faraday Soc., Trans.*, **36**, *pp*. 685–696, *June*, 1940.—The u.v. absorption of some 35 urea and thiourea derivatives has been measured, mostly for the first time, over the range 2 200 to 4 000 Å, and their absorption curves correlated with their chemical constitution as determined from their diamagnetic susceptibilities. AUTHORS.

2146. U.v. band systems of GeSe and GeTe and their relations to those of similar molecules. R. F. BARROW AND W. JEVONS. *Phys. Soc., Proc.*, **52**, *pp*. 534–546, *July*, 1940.—The production of u.v. band systems of 2 of the 3 group-IV(*b*) + group-VI(*b*) molecules which remained to complete the authors' investigations in this series, viz. GeSe and GeTe, is described. They are obtained in emission in silica discharge tubes of the type successfully used in previous work. The bands are degraded to the red and show strong vibrational isotope effects. About 24 band heads have been measured and assigned to a GeSe system lying in the region λ3 170–λ3 570 while a number of weakly developed bands in the region λ3 060–λ2 660 which may belong to a second GeSe system have been measured but not analysed. 29 bands lying between λ3 380 and λ3 830 are assigned to the GeTe system. Band heads of the systems are represented by the equations:

(*i*) GeSe. $\nu_{\text{head}}=30\,431{\cdot}9+(272{\cdot}4u'-1{\cdot}05u'^2)-(406{\cdot}8u''-1{\cdot}2u''^2)$,
(*ii*) GeTe. $\nu_{\text{head}}=27\,969{\cdot}5+(219{\cdot}4u'-1{\cdot}3u'^2)-(323{\cdot}4u''-1{\cdot}0u''^2)$,
where $u=v+\frac{1}{2}$. As a result of this work ground-state data are available for 19 of the 20 molecules of the group, and a fairly complete discussion of the behaviour of the vibrational constants is made possible. The vibrational frequencies, force constants, energies of dissociation and internuclear distances, are considered in turn, and the homogeneity of the group is established to a remarkable degree. Unfortunately the same cannot be said of the upper states of these molecules, data on which are still inadequate in many directions. [See Abstracts 1841 and 1845 (1940).] AUTHORS.

2147. Dissociation of diatomic hydrides and deuterides. Part II. L. GERÖ AND R. SCHMID. *Zeits. f. Physik*, **115**, 1–2, *pp.* 47–54, 1940.—Further proof is brought forward for the fact that the principle of the dissociation of molecular ground levels into atomic ground levels is not universally applicable. The Birge-Sponer method of extrapolation furnishes always an upper limit for the dissociation energy. In the cases of predissociation and subsequent convergence of a molecular term the predissociation and the dissociation are produced by 2 different adjacent combinations of atomic terms. These atomic terms are the 2 components of the ^{2}P halogen ground levels in the case of the Al and B halogenides; in the hydrides the terms are neighbouring excited atomic terms which do not belong to the electronic ground configurations. [For Part I see Abstract 1185 (1940).] L. K.

2148. Spectral energy distribution of infra-red emission (300μ) of high-pressure discharges. W. DAHLKE. *Zeits. f. Physik*, **114**, 11–12, *pp.* 672–681, 1939.—An experimental comparison between the spectral intensity distribution of a Hg high-pressure arc and a black-body radiator shows that the emission of the Hg-arc between 150 and 400 μ represents a continuum with the same energy distribution as a black body. The minima in the emission curve at 120, 175 and 265 μ are due to the absorption of the H_2O vapour in the air as rotation bands of the H_2O molecule occur at 139 μ, between 175 and 180 μ, and between 212 and 304 μ. In an electrodeless ring discharge Hg, Zn and Cd show a similar infra-red emission at high gas pressures to the Hg high-pressure arc with the minima in the same positions. L. K.

2149. Electronic absorption spectra in solution, with special reference to continuous absorption of halogens. N. S. BAYLISS AND A. L. G. REES. *J. Chem. Phys.*, **8**, *pp.* 377–381, *May*, 1940.—The cage theory of liquids has been applied to find the form of potential function that must be added to the $U(r)$ curves of gaseous molecules to give the $U(r)$ curves of dissolved molecules. It is possible to explain the slight displacement of the absorption maximum in halogens dissolved in non-associated solvents, and also the change in the symmetry of the absorption curve. The large displacement of the maximum in associated solvents is due to a slight compression of the solute molecule by the quasi-crystalline structure of such solvents. The relaxation time of the solvent cage is such that band absorption should persist in solution when normal and excited states are of the same size, but that it should disappear when $r_e' > r_e''$. AUTHORS.

2150. Fluorescence and absorption spectra in relation to structure of natural and artificial yttro-fluorite. N. CHATTERJEE. *Zeits. f. Krist.*, **102**, 4, *pp.* 245–284, 1940.—Observations were made on both natural and artificial yttro-fluorite by the use of absorption and emission spectra. In comparison with these Debye-Scherrer diagrams were produced. By correlation of these different methods of observation fresh light has been thrown on the structure of the substances examined. Tables of the spectral observations and reproductions of the photographs taken are given. J. J. S.

2151. Zeeman effect of Xe spark spectrum, Xe II. Parts I and II. H. Angenetter. *Zeits. f. Physik,* **114,** 9–10, *pp.* 636–650, 1939, *and* **115,** 5–6, *pp.* 309–320, 1940.—The Zeeman effect of 126 lines of the Xe spark spectrum has been measured. Humphreys' analysis, which has been confirmed in all details, permits the computation of the *g*-factors of 59 terms. It is shown that Xe II does not possess Russell-Saunders coupling. Strong interaction between neighbouring electronic configurations occurs. L. K.

2152. Fine structure of Stark effect of H_β. W. Steubing and A. Keil. *Zeits. f. Physik,* **115,** 3–4, *pp.* 150–178, 1940.—The Stark effect of H_β has been calculated with the help of Dirac's theory and Schlapp's method, taking the fine structure into account. For fields of 10^4 to 10^5 kV/cm. the displaced lines are shifted asymmetrically with respect to the original line. The observed Stark effect of H_β is in good agreement with the theoretical fine structure effect. A shift of all the displaced lines is superimposed over the fine structure. This shift has different values in different parts of the field. L. K.

2153. Raman spectra of carboxylic acids. K. S. Bai. *Indian Acad. Sci., Proc. A,* **11,** *pp.* 212–228, *March,* 1940.—The Raman spectra are reported for iso-butyric, benzoic, cinnamic, and lactic acids, and for ethyl lactate, and their variation with temperature and state of aggregation is described. Iso-butyric acid behaves as if it had a higher proportion of monomers near the boiling point than at room temperature. Benzoic and cinnamic acids are mostly in the dimeric state in the solid, and on melting a fraction become monomers. Lactic acid is almost completely monomeric, even at ordinary temperatures. Marked changes in the spectrum of cinnamic acid suggests a change from *trans-* to *cis-*form on melting. A. C. M.

2154. Raman effect and crystal symmetry. B. D. Saksena. *Indian Acid. Sci., Proc. A, pp.* 229–245, *March,* 1940.—Results are calculated for the polarizations to be expected in the Raman effect for light incident in different directions related to the structure of the crystal. These results are tabulated for the various crystal classes, and for transverse, longitudinal and circularly-polarized scattering. The theory is applied in detail to the case of $NaNO_3$, when it is found that all results are in exact agreement except those for the strong totally symmetric vibration line. A. C. M.

2155. Raman spectra of ethylene chlorhydrin, *n*-propyl chloride, and *n*-butane in the liquid and solid states. S. Mizushima, Y. Morino and S. Nakamura. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, No.* 963, *pp.* 205–215, *April,* 1940.—The Raman spectra of ethylene chlorhydrin, *n*-propyl chloride and *n*-butane, were observed in the liquid state as well as in the solid state, and the conspicuous difference between the spectra of these two states (i.e. the disappearance of many Raman lines on solidification) was found for each substance. An explanation for this experimental result is suggested as follows: In the liquid state there exists a dynamic equilibrium between the two molecular forms, while in the solid state only one of them is stable. This stable form in the solid state is the *trans* form for ethylene chlorhydrin and *n*-butane, while it is a *gauche* form in the case of *n*-propyl chloride. The chain frequencies of the *trans* form of ethylene chlorhydrin are calculated and the assignment of low frequency lines is made. AUTHORS.

2156. Raman spectra of $P(CH_3)_3$ and $As(CH_3)_3$, and force constants of methyl compounds of fifth group elements. E. J. ROSENBAUM, D. J. RUBIN AND C. R. SANDBERG. *J. Chem. Phys.*, **8**, *pp*. 366–368, *May*, 1940. —The Raman spectra of $P(CH_3)_3$ and $As(CH_3)_3$ have been photographed and studied in relation to the spectra of the methyl compounds of N, Sb and Bi. The low-lying frequencies of all of these molecules can be interpreted in terms of a pyramidal structure with the methyl groups acting as units. The existence of only 2 low-lying lines in the spectra of $Sb(CH_3)_3$ and $Bi(CH_3)_3$ is attributed to an accidental degeneracy resulting from the relatively large mass of the central atom and a particular value of the apex angle. The frequencies computed from a 2-constant valence force potential function are in good agreement with those observed. The force constants obtained are tabulated. AUTHORS.

2157. Hindered rotation. Part I. Configuration of cyclohexane molecule. A. LANGSETH AND B. BAK. *J. Chem. Phys.*, **8**, *pp*. 403–409, *May*, 1940.—A restriction of the free rotation about the C-C single bond will play an important rôle in the potential function of the cyclohexane molecule. Any force whose nature is such that it will produce a hindrance to the free rotation about the C–C bond must also give rise to different potential energies for the " chair " and " tub " forms of cyclohexane even if these forms are " strainless " in the Baeyer theory sense. According to the nature of the rotational restriction (stabilizing " staggered " or " opposed " configurations) either the " chair ", the " tub", or even the hexagonally symmetrical form with a plane C ring, could be the most stable form. From considerations of the obtained Raman spectra of cyclohexane, cyclohexane-d_1 and cyclohexane-d_{12}, it is shown that the only form present in measurable quantities is the form with a D_{6h} symmetry, i.e. the form with the plane of the C ring as a reflection plane for the H atoms. The rotational restriction about the C–C single bond, therefore, is of such a nature that it stabilizes this D_{6h} configuration, in which the H atoms are in " opposed " positions. [See following Abstract.] AUTHORS.

2158. Hindered rotation. Part II. Hindered rotation about C-C single bond in tetrachloroethane. A. LANGSETH AND H. J. BERNSTEIN. *J. Chem. Phys.*, **8**, *pp*. 410–415, *May*, 1940.—Because of the restriction to internal rotation tetrachloroethane might consist of several rotational isomers : a *cis*-(C_{2v}) form, a *trans*-(C_{2h}) form, or forms intermediate to *cis* and *trans* with C_2 symmetry. From the Raman spectrum of $C_2D_2Cl_4$ and the spectrum of $C_2H_2Cl_4$ at different temperatures experimental evidence has been obtained which shows that the equilibrium mixture consists of 2 rotational isomers, the *cis*-C_{2v} form and the C_2 form. The C_{2v} form was found to be the more stable, with a potential energy 1 100 cal./mole lower than the potential energy of the C_2 form. [See preceding and following Abstract.] AUTHORS.

2159. Hindered rotation. Part III. Qualitative nature of interactions hindering internal rotation. A. LANGSETH, H. J. BERNSTEIN AND B. BAK. *J. Chem. Phys.*, **8**, *pp*. 415–418, *May*, 1940.—Experimental evidence shows that an important contribution to the potential barrier hindering internal rotation is an interaction stabilizing " opposed " configurations. A qualitative picture of this interaction, which is considered as arising in the bond connecting the two halves of a molecule, is presented, based on the symmetry properties of the molecule and the ideas associated with overlapping of wave functions. This interaction seems to be of chief importance in hydrocarbons where dipole and steric effects are small, such as ethane, propylene, toluene, cyclohexane, dimethylacetylene. Even in compounds where the dipole effect is great, such as tetrachloroethane and dichloroethylene, this interaction plays the most important rôle. [See preceding Abstract.] AUTHORS.

See also Abstract 1978.

TRANSMISSION.

See Abstract 2010.

VISION.

2160. Characteristics of protanomalous vision. W. M. MCKEON AND W. D. WRIGHT. *Phys. Soc., Proc.*, **52**, *pp.* 464–479, *July*, 1940.—The colour vision of 11 protanomalous observers, selected from about 2 000 persons, has been tested in detail. The measurements include the luminosity curve, the mixture curves, the trichromatic coefficients through the spectrum, the hue discrimination curve and the saturation discrimination curve. The observers have been arranged in order of increasing seriousness of the defect and the hue discrimination results yield a family of curves ranging between that for the normal trichromat and that for the protanopic type of dichromat. The luminosity data, on the other hand, vary little from observer to observer and the mean curve is almost identical with that of the protanope in the red-yellow-green region of the spectrum. This result is difficult to reconcile with the ordinary conception that different degrees of protanomalous defect arise from the magnitude of the red response varying from one observer to another. AUTHORS.

X-RAYS.

2161. New X-ray effect. C. V. RAMAN AND P. NILAKANTAN. *Current Science*, **9**, *pp.* 165–167, *April*, 1940.—The effect of the periodic variation of the structure amplitude of a crystal on the reflection of X-rays is discussed, and experimental results are given for diamond irradiated with X-rays from a 41 kV tube with a Cu target. The Laue photograph shows that the spots due to the usual reflection from the [111] plane are accompanied by faint companions which are explained as being due to the reflections of the CuK_α and CuK_β radiations from a modified [111] plane. This modification is, in effect, a slight change of inclination of the [111] plane due to the excited lattice vibrations set up by the X-rays. W. E. D.

2162. Preliminary experimental study of new diffraction maxima in X-ray photographs. S. SIEGEL AND W. H. ZACHARIASEN. *Phys. Rev.*, **57**, *pp.* 795–797, *May* 1, 1940.—A revised theoretical treatment of the diffuse scattering of X-rays by crystals predicts a rapid variation of intensity with scattering angle, thus leading to intensity maxima in specific directions. The new diffraction maxima were observed with a rock-salt crystal and Cu $K\alpha$ radiation. The peak intensities and the half-widths were studied as functions of the direction incidence. The observations were found to be in general agreement with theory. [See Abstract 1586 (1940).] AUTHORS.

2163. $L\alpha$ satellite lines for elements Mo(42) to Ba(56). C. A. RANDALL AND L. G. PARRATT. *Phys. Rev.*, **57**, *pp.* 786–791, *May* 1, 1940.—The X-ray satellite lines accompanying the $L\alpha_{1,2}$ emission for elements Mo (42) to Ba(56) have been systematically studied with a 2-crystal vacuum spectrometer. Integrated relative intensities of the satellite group agree qualitatively but differ by a factor of about 6 with previous photographic measurements. The abrupt intensity change at Z = 50 (the element at which the Coster-Kronig " cross-over " occurs) further confirms qualitatively the Coster-Kronig interpretation of Auger production of the initial state in satellite emission. The observed satellite contour for each element has been resolved arbitrarily into constituent component lines and wavelengths and relative intensities measured. A few hitherto unreported satellite components are found: Theory predicts 15 $L\alpha$ satellite components for Au(79), about twice as many as are included in the present analyses for the intermediate atomic numbers. The components farthest removed from the $L\alpha_1$ line seem not to exhibit the abrupt intensity change at Z = 50 and, therefore, may not be from the $L_{III} M_{IV, V}$ initial state. These components may be Wentzel-Druyvesteyn satellites from another initial state or they may be Richtmyer satellites. AUTHORS.

2164. Fringes in the region of K discontinuity of X-rays. C. KURYLENKO. *J. de Physique et le Radium*, **1**, *pp.* 133–145, *April*, 1940.—A summary is given of the theories of Brillouin and Kronig, together with the results of several experiments on the fine structure of the K absorption edge for various materials. It is also shown that there is a movement of the K edge toward the longer wavelength when the material is subject to an intense magnetic field (10 000 gauss). The various experiments indicate that the fine structure depends on the crystal structure. Measurements on Fe at both — 180°C. and 960°C. indicate a movement of the K edge from its position at 20°C. by an amount 0·34 X.U. towards the longer wavelengths in each case. At 960°C. Fe is in the γ state, the crystalline structure then being similar to that of Cu, and this is revealed in the similarity of the fine structure. The K absorption edge is examined for various compounds of Cu and Fe. Evidence is obtained in support of the hypothesis of Pauling and Brockway that $CuFeS_2$ is composed of a mixture of $Cu^{II}Fe^{II}S_2$ and $Cu^{I}Fe^{III}S_2$. A hump in the main part of the K edge for Fe_3O_4 indicates the presence of Fe^{II} and Fe^{III}. Similar evidence, and also change of colour, is given for the decomposition of $K_4Fe(CN)_6$ under prolonged X-ray irradiation. The fine structure is considered from a general theoretical point of view. The results have the same trend as the experimental results for the part far removed from the main edge, but there is disagreement for the part closer in. By consideration of the reflection power of the various net planes of FeF_2 an explanation is given of the anomaly in the K absorption edge. W. E. D.

2165. K-absorption edges of Br(35) and Kr(36). C. H. SHAW. *Phys. Rev.*, **57**, *pp.* 877–881, *May* 15, 1940.—The absorption of monochromatic X-rays as a function of the wavelength has been measured for gaseous Kr, Br and HBr, in the region of the absorption edges. The data were taken with a double-crystal spectrometer with a G-M counter to measure the X-ray intensities. The structure for Kr is considerably different from that previously obtained for A. The data for Br_2 and HBr are of sufficient accuracy so that they may be used to check the Kronig-Petersen theory quantitatively. [See following Abstract.] AUTHOR.

2166. Fine structure of X-ray absorption limits of Br and Cl. T. M. SNYDER AND C. H. SHAW. *Phys. Rev.*, **57**, *pp.* 881–886, *May* 15, 1940.—The ratio of the absorption coefficient of the Br atom in Br_2 to that in HBr for monochromatic X-rays is calculated as a function of the X-ray wavelength in the region of the K-absorption edge according to the theory as given by Petersen. A predicted minimum at about 5·9 V on the h.f. side of the absorption edge agrees satisfactorily with the experimental findings in position but not in intensity. A predicted broad maximum at about 15 V from the absorption edge is not found experimentally. The structure for Cl is recalculated from the Hartree self-consistent field for the Cl atom and is compared with previous photographic measurements. [See preceding Abstract.] Authors.

2167. Structure of L-absorption of Na and its halides. H. M. O'Bryan. *Phys. Rev.*, **57,** *pp.* 995–997, *June* 1, 1940.—The structure of the soft X-ray absorption of thin films of Na, NaF, NaCl, NaBr, and NaI has been photographed in the region between 250 and 430 Å with a plane grating vacuum spectrograph having a resolving power of 0·1 eV. The structure is much narrower and more complicated than found in the K-absorption spectra for the same compounds. The sodium halides have narrow intense absorption " lines " beginning near 380 Å and extending toward shorter wavelengths. These absorption " lines " of these crystals have widths at half-maximum intensity as small as 0·3 eV and almost the same wavelength as the emission of NaII in the vacuum spark. Na has a sharp edge at 405 Å and relatively faint structure at shorter wavelengths. Continuous absorption in the halides starts near 45 eV, corresponding to the ionization potential of the free ion at 47 eV, and is probably due to transitions to the conduction states of the crystal lattice. These similarities between the energy levels of the Na ion in these crystalline solids and in the free ions indicate a highly ionic character of the halides and surprisingly little broadening and displacement by neighbouring ions in the crystals. Author.

***2168. Luminous and high resolving universal X-ray spectrograph.** E. Ingelstam. *Rev. Sci. Instruments,* **11,** *pp.* 160–164, *May,* 1940.—A universal spectrograph combining the concave-crystal methods by internal and external reflection has been constructed. The crystal employed covers the wavelength domain 0–2 300 X.U. The aim was to get a convenient instrument suitable for rapid work. Direct wavelength reading is possible. Technical improvements in the crystal holder have been made. Author.

2169. X-ray measurement of strains in light metals. O. Schaaber. *Zeits. f. techn. Physik,* **20,** 9, *pp.* 264–278, 1939.—The solution of the exact conditions for the determination of any two mutually perpendicular components, σ_x and σ_y, of a 2-dimensional state of strain from a rotated perpendicular X-ray photograph and from one of two inclined exposures is given using the corrected line intervals Δ. The influence of the penetration depth of the X-rays on the determinations of strain is discussed. The mathematical conditions for the calculation of a 3-dimensional state of strain from X-ray measurements are given. G. O. B.

2170. X-ray shadow enlargements. R. Glocker and O. Schaaber. *Zeits. f. techn. Physik,* **20,** 10, *pp.* 286–289, 1939.—A process is given of optical enlargement by an X-ray picture taken by a fine-focus X-ray tube on very fine grain film, which increases the sharpness of detail and power of resolution. The efficiency of direct X-ray enlargement and optical enlargement of X-ray pictures is compared in relation to sharpness. An increased reproduction of false spots, whose linear spreading is smaller than the least technically obtainable hot spot diameter, is only possible with optical photographic enlargement of an X-ray photograph on specially fine grain film. G. O. B.

***2171. New form of Sauter X-ray goniometer.** D. E. THOMAS. *Journ. Sci. Instruments*, **17**, *pp.* 141–149, *June*, 1940.—The paper describes a new form of Sauter's X-ray goniometer which secures the necessary synchronism between the rotations of the crystal and film by driving them with two small synchronous a.c. motors instead of by using gearing. The film can be used normal to the incident X-rays or inclined at an angle (usually 45°) so that the more deviated and weaker reflexions fall less obliquely on the film than when in the normal position. In both these film positions equatorial and layer line reflections can be obtained. The theory of the apparatus is explained and it is shown how the reciprocal lattice can be obtained from the polar co-ordinates on the film. AUTHOR.

See also Abstract

1152B. Detection of defects by technical radiography. E. A. W. Müller.

HEAT.

CALORIMETRY.

***2172. Specific heat of Mn from 16° to 22°K.** R. G. ELSON, H. G. SMITH AND J. O. WILHELM. *Canad. J. of Research, A*, **18**, *pp.* 83–89, *May*, 1940.—A calorimeter is described for routine measurements of specific heats in the temperature region of liquid H_2 and liquid He. It is designed so that samples can be interchanged without disturbing the calibration of the thermometer or the water equivalent of the calorimeter. The calorimeter has been used to measure the specific heat of Mn from 16° to 22°K. It was found that the atomic heat of this metal is given by the formula $C = 0{\cdot}004\,21T + 464[T/410]^3$. AUTHORS.

CONVECTION.

2173. Temperature and flow field for free convection round a horizontal quadratic plate. W. KRAUS. *Phys. Zeits.*, **41**, *pp.* 126–150, *March* 15, 1940.—The temperature field round a quadratic plate of the dimensions 240 × 240 × 15 mm. has been measured at a surface temperature of 319·4°C. with thin thermocouples. The temperature distribution is given in diagrams. The velocity distribution of the flow above and below the plate has been measured with a quartz-filament anemometer for the same surface temperature. The spatial field of the flow is illustrated by stereoscopic photographs of a model. The entire loss of heat has been determined for 3 horizontal plates at temperatures of 50-300°C. above room temperature. By comparison with the loss of heat from blackened plates, all other conditions being equal, the loss by radiation was separated from the loss by convection. [See Abstract 2155 (1928).] L. K.

DILATATION.

2174. Variation of thermal dilatation and electrical resistance for the transition of γ-Mn to α-Mn. H. D. ERFLING. *Ann. d. Physik*, **37**, 2, *pp.* 162–168, *Jan.*, 1940.—The thermal dilatation and the electrical resistance of electrolytically obtained soft γ-Mn are measured and the changes which occur during the transition into the hard and brittle α-phase are investigated. The mean linear thermal expansion coefficient has, between 0° and + 20°C., the value $14\cdot75 \times 10^{-6}$ for γ-Mn and $22\cdot29\times10^{-6}$ for α-Mn. The variation of the expansion coefficient of α-Mn corresponds to a θ-value of 460 for higher temperatures. The specific resistance of γ-Mn has the value of $0\cdot39 \times 10^{-4}$ at 0°C. while the corresponding value of α-Mn is $6\cdot3 \times 10^{-4}\,\Omega \times$ cm. The temperature coefficients between 0°C. and room temperature have the values 0·006 28 for γ-Mn and 0·000 215 for α-Mn. L. K.

2175. Comparison of X-ray and optical interferometer methods of determining linear thermal expansion. Evidence of differences among calcite crystals. J. B. Austin, H. Saïni, J. Weigle and R. H. H. Pierce, Jr. *Phys. Rev.*, **57,** *pp.* 931–933, *May* 15, 1940.—Measurements by the X-ray and optical interferometer methods on the same specimen of calcite gave values for the coefficient of linear expansion which agree within the limit of measurement. Comparison of these results with data for other crystals of calcite shows that there is a significant difference in the expansion of different crystals. The spacing between the (211) [((100))] planes is also measurably different. Authors.

FUSION AND SOLIDIFICATION.

2176. Melting-point curves of the gases A, Kr, X, CH_4, CH_3D, CD_4, C_2H_4, C_2H_6, COS and PH_3 up to 200 atm. pressure. K. Clusius and K. Weigand. *Zeits. f. phys. Chem.*, *B*, **46,** 1, *pp.* 1–37, 1940.—The value of dp/dT at the triple point of the melting-point curves has been measured for A, Kr, X, CH_4, CH_3D, CD_4, C_2H_4, C_2H_6, COS and PH_3. The experimental method consists of the determination of the solidification temperatures of the liquid gases with a vapour-pressure thermometer when the gases are cooled under pressure [see Abstract 5112 (1935)]. The volume difference between liquid and solid phase can be calculated from the triple-point temperature, the inclination of the melting-point curve and the heat of fusion. Where reliable observations of the density of the liquid phase are available, the density of the crystalline phase at the melting point can be computed. The results show that for certain groups, e.g. the inert gases or the H isotopes, the same relative changes of the volume occur at the melting point. A model of the atomic or molecular configuration in liquids is developed which furnishes for the inert gases $v_{\text{liquid}}/v_{\text{solid}} = 1\cdot140$, in good agreement with the observations. It is pointed out that the volume ratio can be lowered by steric effects and association. It will be raised by the appearance of new degrees of freedom during the process of melting. The entropy of fusion changes in the same way as the relative volume. L. K.

2177. Preparation and physical properties of 2,2,4,4-tetramethylpentane. F. L. Howard. *Bureau of Standards, J. of Research*, **24,** *pp.* 677–684, *June*, 1940.—Over 2 l. of purified 2,2,4,4-tetramethylpentane was prepared synthetically. Physical constants determined on the purest fraction included freezing point, boiling point and its variation with pressure, and refractive index and density and their variations with temperature. Author.

TEMPERATURE.

***2178. Mercury recording thermometer for use over long periods of time.** L. O. Cook. *Journ. Sci. Instruments*, **17,** *pp.* 161–162, *June*, 1940.—

This recorder was developed for the purpose of recording temperatures of experimental tanks, also for hydrographic survey, etc. The record is obtained by casting the shadow of a flat-section mercury column of a thermometer on to bromide paper on film, by a feeble source of light. The recorder is actuated by a constant clock with an intermediate mercury-in-glass type of switch operating a relay which drives the drums carrying the paper. The thermometer is graduated in half degrees, and a tenth of a degree is easily estimated. This recorder requires very little attention.

AUTHOR.

See also Abstract 2137, and
1160B. Pyrometric regulation of resistance furnaces. A. Clergeot.
1205B. Temperature of flame gases. W. T. David.

THERMOCHEMISTRY.

2179. Heat content and lattice state of activated Ni. R. FRICKE AND W. SCHECKENDIEK. *Zeits. f. Elektrochem.*, **46**, *pp.* 90–95, *Feb.*, 1940.—The activated Ni was prepared in various ways—from the hydroxide, sesquioxide and from the carbonate, reduced at various temperatures. The heat of solution was found by dissolving the metallic preparation in solutions of ICl_3 in HCl, and an X-ray investigation of the various specimens was carried out. The pyrophoric preparations had a heat of solution approximately 1·75 kg. cal. per gm. atom greater than the non-pyrophoric ones. The cause of the increase in the heat content, and thus in the heat of solution, was traced to the existence of slight irregularities in the lattice, to the admixture of amorphous material, and to the difference in size of the primary particles. The pyrophoric preparations prepared at low temperatures retain this property after heating for hours at 230°C. in N_2 free from O_2. G. G.

2180. Heats of formation of Al_2O_3 and La_2O_3. W. A. ROTH, U. WOLF AND O. FRITZ. *Zeits. f. Elektrochem.*, **46**, *pp.* 42–45, *Jan.*, 1940.—Using the purest available Al and the latest technique of the calorimetric bomb the heat of formation of Al_2O_3 has been found to be $402{\cdot}9 \pm 0{\cdot}3$ kg. cal. at 22°C. and constant pressure, an increase being found over the former accepted value of 393 kg. cal. The heat of formation of Al_4C_3 was found to be 50 ± 3 kg. cal., which is said to be a much more probable value than the former one of 20 kg. cal. The heat of formation of La_2O_3 was found as 539 ± 4 kg. cal. at 22°C. and constant pressure. La_2O_3 occurs in two modifications, the one stable at lower temperature having the greater molecular volume. G. G.

2181. Heats of formation of Cr_2O_3. W. A. ROTH AND U. WOLF. *Zeits. f. Elektrochem.*, **46**, *pp.* 45–46, *Jan.*, 1940.—The heat of formation of Cr_2O_3 at 21°C. and constant pressure is found to be 268·9 kg. cal. The heat of the reaction $2\,CrO_3 = Cr_2O_3 + 1\tfrac{1}{2}\,O_2$ is $-\,5{\cdot}3 \pm 0{\cdot}2$ kg. cal., thus giving a new value for the heat of formation of Cr_2O_3 of $137{\cdot}1 \pm 0{\cdot}4$ kg. cal. at approximately 20°C. and constant pressure. G. G.

2182. Surface energy of CdO and heat of formation of $Cd(OH)_2$. R. FRICKE AND F. BLASCHKE. *Zeits. f. Elektrochem.*, **46**, *pp.* 46–49, *Jan.*, 1940.—By dehydration of $Cd(OH)_2$ at 350°C. a greenish yellow form of CdO is obtained, and by dehydration at 800°C. a deep blue-black form is obtained. The pale one has a molar heat content 0·56 kg. cal. greater than the dark form. X-ray analysis showed a considerable difference in the size of the particles of the two forms—190 and 2 500 Å. From this difference in heat content and particle size a lower limit of 500 erg/cm².

can be estimated for the total surface energy of CdO. The heat of formation of $Cd(OH)_2$ from CdO and liquid H_2O varies between 5·30 and 4·74 kg. cal. depending on the CdO. G. G.

THERMODYNAMICS.

2183. Fundamental principles of energetics. J. N. BRØNSTED. *Phil. Mag.*, **29**, *pp.* 449–470, *May*, 1940.—This paper, which attempts to elucidate the relation between heat, A, and work, Q, on a broader and more rational basis than heretofore, embraces the following sections :—the concept of work and the work principle, entropy and temperature, the concept of heat and energetic heat evolution, energy, heat and work in traditional thermodynamics, and the fundamental principles of energetics. A law which is regarded as being universally true is that $\Sigma A = Q$ and is greater than, equal to, or less than zero, according as the process is irreversible, reversible or imaginary. R. W. P.

2184. Thermal and caloric difference effects of ortho- and para-H_2. K. SCHÄFER. *Zeits. f. phys. Chem.*, *B*, **45**, 6, *pp.* 451–464, 1940.—Theoretical arguments show that the thermal and caloric differences between o-H_2 and p-H_2 as well as between o-D_2 and p-D_2 can be explained by the effect of an inner field. The discrepancies between the author's former theory [see Abstract 1723 (1939)] and experimental results are due to the temperature variation of the inner field. A detailed calculation of this temperature variation is given. The thermal and caloric differences are therefore founded entirely on different states of orientation in the o-H_2 and p-H_2. A difference in the molecular forces (van der Waals forces) is not decisive, contrary to the ideas of Urey and Cohen [see Abstracts 1722 and 4098 (1939)]. L. K.

2185. Gibbs' canonical ensemble and the distribution law in statistical mechanics. T. SAKAI. *Phys. Math. Soc., Japan, Proc.*, **22**, *pp.* 199–207, *March*, 1940.—The distribution law for an assembly of molecules in a state of equilibrium is obtained by various methods. Variously, these are the Boltzmann and Darwin-Fowler methods and that of Gibbs, using the canonical ensemble and the grand ensemble. The present paper gives a simple method, using the canonical ensemble, which is applicable to all statistics. The cases of states of non-equilibrium will be considered on another occasion. S. A. S.

See also Abstracts 2043, 2140.

VAPORIZATION AND CONDENSATION.

2186. Evaporation velocity of liquids. W. PRÜGER. *Zeits. f. Physik*, **115**, 3–4, *pp.* 202–244, 1940.—The evaporation velocity of water and CCl_4 has been measured at the normal boiling point of the liquids. A thermocouple of 0·04 mm. dia., horizontally adjusted, was used to measure the surface temperature of the evaporating liquid. Water possesses an evaporation coefficient of 270×10^{-6} [cm./sec. × mm. Hg], i.e. a condensation coefficient of 2%. This latter coefficient has a value of 1 for CCl_4 which has no dipole moment. If water is evaporated in glass vessels, the evaporation coefficient decreases through the action of glass particles dissolved in the water surface. The superheating in the surface amounts to 0·01°C. for water and to 0·001°C. approximately for CCl_4. The temperature gradient from the surface to the interior of the liquid can amount to several degrees in a boundary layer of a few tenths of 1 mm. L. K.

2187. Condensation from vapour mixtures of many components. V. FISCHER. *Ann. d. Physik*, **37**, 1, *pp.* 63–68, *Jan.*, 1940.—The equilibrium conditions in a mixture of an arbitrary number of components are investigated [see Abstract 817 (1940)]. Formulae are derived which describe the process of condensation in the mixture. The mixtures of *n*-pentane-*n*-butane-propane-ethane and *n*-pentane-*n*-butane-propane-ethane-hydrogen are treated in detail. L. K.

2188. Vapour pressure of liquid Bi between 603 and 638°C. A. H. WEBER AND S. C. KIRSCH. *Phys. Rev.*, **57**, *pp.* 1042–1044, *June* 1, 1940.—The vapour pressure of liquid Bi in the temperature range 603–638°C. has been measured by the method of molecular effusion. The weights of the metallic deposits were determined directly with a microbalance. The 7 experimental values reported are fairly well represented by the empirical equation : $\log_{10}p$ (in mm.) $= -52 \cdot 23(205)/T + 9 \cdot 03$. This expression is in very good agreement with that given in the "International Critical Tables." AUTHORS.

***2189. Sensitive method for determination of moisture, applied to electrical insulating materials.** R. S. VINCENT AND A. SIMONS. *Phys. Soc., Proc.*, **52**, *pp.* 489–500, *July*, 1940.—A method is described for measuring the absorbed moisture in paper, whether impregnated or unimpregnated, down to values of the order of 0·01%. The essential feature of the method is the establishment of the equilibrium water-vapour pressure of the sample at a chosen temperature in a known space. A new form of absorption apparatus is employed to measure the equilibrium water-vapour pressure, and from such measurements the original total adsorbed moisture in the sample is derived by means of a simple graphical extrapolation. Once the relation between the equilibrium vapour pressure and the percentage of moisture has been established for a particular material, a single vapour-pressure measurement suffices to determine the moisture content of the sample. Determinations can be carried out on samples containing as little as 0·1 gm. of paper, thus making it possible to explore the distribution of moisture through the insulation wall of a h.v. cable. AUTHORS.

***2190. Equipment for conditioning materials at constant humidities and at elevated temperatures.** J. G. WIEGERINK. *Bureau of Standards, J. of Research*, **24**, *pp.* 639–644, *June*, 1940.—Equipment is described for the study of the moisture relations of materials in air of controlled relative humidities at elevated temperatures. The air is brought to the desired relative humidity and temperature by an arrangement including a saturator and automatically controlled heaters, and then passed through a working chamber in which the materials to be studied can be weighed rapidly and accurately. Provision is made for measuring the rate of flow of air and for accurately determining the relative humidity in the working chamber. The equipment has been used at temperatures from 96° to 300°F., at relative humidities from 10 to 90% for temperatures up to 212°F., and up to the maximum relative humidities obtainable at atmospheric pressure for temperatures between 212° and 300°F. The temperature in the working chamber can be maintained constant within ±0·4°F. and the relative humidity within ±1% relative humidity for experimental runs of several days' duration. Data are given illustrating the performance of the equipment. [See following Abstract.] AUTHOR.

2191. Moisture relations of textile fibres at elevated temperatures. J. G. WIEGERINK. *Bureau of Standards, J. of Research*, **24**, *pp.* 645–664, *June*, 1940.—The moisture contents of 10 kinds of textile fibres in the form of specially prepared yarns, were determined when the fibres were in equilibrium with air for a series of relative humidities and temperatures. Data were obtained for both " desorption " and " adsorption", the yarns being brought to equilibrium from a wet condition and a dry condition respectively. The fibres studied were raw cotton, " purified " cotton, mercerized cotton, clothing wool, carpet wool, viscose rayon, cuprammonium rayon, raw silk, degummed silk and cellulose acetate. The temperatures ranged from 96° to 302°F., and the relative humidities ranged from 5 to 90% for temperatures below 212°F. and up to the maximum obtainable at atmospheric pressure above 212°F. The results are given in the form of graphs showing moisture content against relative humidity and also in the form of graphs in which the logarithms of the moisture contents at given relative humidities are plotted against the reciprocals of the corresponding absolute temperatures The last show straight-line relationships with changes in the slopes of the lines between 200° and 220°F. [See preceding Abstract.] AUTHOR.

See also Abstracts 1995, 2044, 2101, 2177 and

1166B. Drying process in paper, determined by electrical methods C. G. Garton.

ACOUSTICS.

2192. Acoustic radiation pressure. G. RICHTER. *Zeits. f. Physik*, **115, 3–4**, *pp*. 97–108, 1940.—A short representation of the theory of sound radiation pressure is given following the theories of Rayleigh, Langevin and Brillouin. The reason for the discrepancy between these calculations and a recent paper by Schaefer is found in the choice of an integration constant which refers to different experimental cases. Schaefer's results apply to a sound field which is connected with a reservoir of a stationary liquid under normal pressure so that the average density in the wave field may vary. Rayleigh considers a sound field which is surrounded on all sides by rigid walls so that the average mass density is invariant. The impulse of a purely periodic sound wave always disappears. A new derivation is given of the pressure occurring in a volume with rigid boundaries in the case of plane waves for an arbitrary equation of state. C. SCHAEFER [*ibid*., *pp*. 109–110] explains the discrepancy between his theory and Rayleigh's formula. The latter applies only to a special case. L. K.

2193. Vibrations of free square plates. Part II. Compounded normal modes. M. D. WALLER. *Phys. Soc., Proc.*, **52,** *pp*. 452–455, *July*, 1940.—The nodal designs obtainable on free square plates which cannot be included among the 7 normal classes of figures [see Abstract 4111 (1939)] usually consist of 2 compounded modes of vibration of near period for which the sum $m^2 + n^2$ is approximately equal. Such combination of modes is possible because the internal damping of the material of the plate reduces the sharpness of resonance and because the material and dimensions of the plate are seldom ideally uniform. The observations are in close agreement with the theory proper to a thin elastic plate, a conclusion which may be contrasted with the case of the circular plate [see Abstract 273 (1938)] where, for reasons given, the observations made on higher tones are not in agreement with this theory. AUTHOR.

2194. Propagation of supersonics in liquids. E. G. RICHARDSON. *Phys. Soc., Proc.*, **52**, *pp.* 480–488, *July*, 1940.—By means of a hot-wire detector of amplitude the propagation constants (of velocity and attenuation) of supersonic radiation within the range 200 to 1 110 kc./s. in water and a number of organic liquids are determined. While no dispersion of velocity is found, attenuation coefficients greater than those indicated by the Stokes-Kirchhoff formula (viscous absorption only) are obtained. Measurements of the supersonic field in front of the source do not reveal any abnormalities in the propagation of the radiation in certain organic liquids, as some other workers have claimed. AUTHOR.

2195. Impact sound transmission through floors. R. LINDAHL AND H. J. SABINE. *Acoustical Soc. of America, J.*, **11**, *pp.* 401–405, *April*, 1940.—Tests were made on a concrete floor separating two stories in a warehouse. Small panels, 24 to 27 in. square, of various flooring materials were applied to the bare floor, all in the same room and adjacent to each other. A portable tapping machine delivered 440 impacts per min., and the noise was measured by a sound-level meter combined with a set of band-pass filters designed to pass any one of 7 frequency bands with their centres at octave intervals from 64 to 4 096 c./s. Figures are given for the noise transmitted and the noise in the room above, and all are compared with those for the bare concrete floor taken as a standard. G. E. A.

2196. Effect of painting on sound absorption of acoustic materials. V. L. CHRISLER. *Bureau of Standards, J. of Research*, **24**, *pp.* 547–553, *May*, 1940.—A brief discussion is given of the properties of a material that cause it to absorb sound. Photographs are shown and the results of sound-absorption measurements are given for a number of different types of material before and after painting. A brief discussion is given of the kind of paint which should be used and how it should be applied to minimize the effect of the painting on the acoustical properties. AUTHOR.

***2197. Amplifying power of ear trumpets.** Y. ROCARD. *Rev. sci., Paris*, **78**, *pp.* 146–148, *March*, 1940.—Taking the amplification of an ear trumpet to be the ratio of the sound pressure in the throat of the trumpet to the sound pressure at the mouth in the absence of any trumpet and making certain assumptions, a general formula is obtained for the amplification. The general formula is then applied to the case of an exponential horn with a microphone at the throat, so that the acoustic impedance can be assumed infinite. The resulting curve showing the amplification as a function of frequency has a number of pronounced resonances and approximates to the curve obtained experimentally, though in the latter the maxima are not so pronounced. This is easily explained by the fact that in the calculations all the causes of absorption of energy, notably the effect of viscosity, are neglected. A. W.

2198. Selective amplification in hearing-aids. N. A. WATSON AND V. O. KNUDSEN. *Acoustical Soc. of America, J.*, **11**, *pp.* 406–419, *April*, 1940.—Selective amplification varies in amount at different speech frequencies; it is a controlled variation from uniform amplification. For an ear with perceptive impairment the threshold of hearing curve is markedly raised, usually more at the higher frequencies than at the low. The auditory sensation area is therefore smaller than normal and is often greatly distorted, and speech sounds must be placed within this area in order to be heard. A group of 75 one-syllable words is used for articulation tests, one-third for vowels and the rest for consonants, and the threshold level of speech for each ear is determined. Further tests are conducted at various levels above threshold and the percentage syllable articulation (p.s.a.) is calculated from the Fletcher-Steinberg formula. The results are then given for the increase in p.s.a. with increase in intensity level in the cases of observers with impaired hearing. It is shown that any method of prescription which depends on the observer's judgment of the best type of amplification is extremely unreliable, and the authors base their criterion on a "most comfortable equal loudness curve". The technique required to determine this is described, and results of its application are given.

G. E. A.

2199. Acquired and inherited deafness in animals. M. H. Lurie. *Acoustical Soc. of America, J.*, **11**, *pp.* 420–426, *April*, 1940.—Deafness is distinguished as middle-ear or conduction deafness and nerve or perception deafness. Retraction of the drum due to a blocked Eustachian tube is one of the commonest causes of conduction deafness, and the loss is chiefly in the low tones. Nerve deafness can be inherited or it may be acquired by trauma, poisoning by drugs or disease. A description of the histological structures of the organ of Corti is given. The great part of the organ rests on the basilar membrane, and exposure of the organ to loud noises causes a degeneration of the external hair cells with loss of sensory response as in boilermaker's deafness. This form of degeneration causes loss of hearing up to 30 db. The internal hair cells are the chief functioning sensory cells in the nerve-deaf person, and they respond only to sounds of greater intensity than the external hair cells. With loss of both kinds of cells there is complete deafness for the region of the basilar membrane involved. G. E. A.

2200. Genesis of absolute pitch. A. Bachem. *Acoustical Soc. of America, J.*, **11**, *pp.* 434–439, *April*, 1940.—The persons tested were chiefly those possessing a sense of absolute pitch [see Abstract 5413 (1937)]. Several authors claim that absolute pitch can be acquired by training; these were dealing with pseudo-absolute pitch. The conclusion arrived at is that inheritance, attention and experience, are the important factors for the creation of genuine absolute pitch. Inheritance of the faculty is of prime importance in the talented musician, attention the important item in the blind, and experience determines the degree and extent of the final product, particularly in the professional musician.

G. E. A.

2201. Just intonation. L. S. Lloyd. *Acoustical Soc. of America, J.*, **11**, *pp.* 440–445, *April*, 1940.—A discussion on the relation between music and acoustics, in which the following points may be cited. There is considerable variety in the melodic scales evolved by different peoples, and in a given melodic scale there is little rigidity of intonation. Violinists playing unaccompanied, or 3 or 4 performers singing concurrent melodies, use quite a flexible intonation. The approach to music through counterpoint presents a picture which is wholly consistent with that presented by physiological acoustics and the theory of hearing. The first principle to be laid down is to study counterpoint first, and through counterpoint to master harmony. G. E. A.

2202. Paradox of voice teaching. W. T. Bartholomew. *Acoustical Soc. of America, J.*, **11**, *pp.* 446–450, *April*, 1940.—The voice mechanism is described in detail. It is pointed out that the nose and head passages

add practically nothing in the way of useful resonance, but yet are important in securing indirectly a proper setting of the throat resonators.
G. E. A.

2203. Resonant frequencies and damping constants of resonators involved in the production of sustained vowels "O" and "Ah". D. Lewis and C. Tuthill. *Acoustical Soc. of America, J.*, **11**, *pp.* 451–456, *April*, 1940.—A method has previously been described [see Abstract 5212 (1936)] for determining the resonant frequencies and damping constants of the principal resonators involved in the production of sustained vocal tones. This method has been applied in an investigation of the production of sustained vowels " O " and " Ah " by trained male singers. The results obtained show that 2 l.f. resonators and at least 2 h.f. resonators of importance are typically involved. A possible, though unlikely, exception is that, in the case of high pitched tones, only 1 l.f. resonator is involved. The 2 l.f. resonators are undoubtedly crucial in the determination of vowel character, while the h.f. resonators probably contribute only to less basic tonal qualities. Within certain limits, there are many specific energy spectra which correspond to either " O " or " Ah", just as there are many different perceptual varieties of each vowel, " Ah " is probably more variable than " O ".
A. W.

2204. Experimental investigations of vocal pitch in speech. G. Fairbanks. *Acoustical Soc. of America, J.*, **11**, *pp.* 457–466, *April*, 1940.—An account is given of 4 recent investigations dealing with different aspects of the same general problem : the fundamental pitch of the male voice during speech. The apparatus used was a modified oscillograph permitting measurement of fundamental sound-wave frequencies from photograph recordings by phono-photographic means. The first investigation was concerned with the pitch characteristics of the voice during the simulation of specific emotional states, as contempt, anger, fear, grief, indifference. For these, typical pitch curves are given and the results summarized. The second investigation relates the fundamental vocal pitches used in speech to the range of frequencies the larynx is capable of producing, i.e. the maximum singing range. The third investigation was concerned with the relation between pitch level and pitch variability, while the fourth dealt with the phenomenon of voice change in the adolescent male.
A. W.

***2205. Hearing-aid for research and group use.** E. W. Marchant and T. H. Turney. *Journ. Sci. Instruments*, **17**, *pp.* 149–155, *June*, 1940.—The construction of a new form of deaf aid amplifier, which has been used by a class of partially deaf students and also in connection with research on the value of tone control for the partially deaf, is described. The amplifier enables the gain of 3 separate bands of frequencies to be varied. The results of tests with this amplifier using piezo-crystal headphones are given.
Authors.

See also Abstracts 1972 and
1240B. Sensitive flames for signalling. Z. Carrière.
1327B. Attenuation of sound in tubes. R. Rogers.

ELECTRICITY AND MAGNETISM.

ALTERNATING-CURRENT NETWORKS.

See Abstracts 2011, 2225, and
1172B. Application of matrices in electrical engineering. F. Strecker.
1175B. Resistance networks. Complete design tables. C. D. Colchester and M. W. Gough.

CONDUCTION AND DISCHARGE IN GASES.

2206. Collisions between 3 particles in gas discharges. R. Rebsch. *Zeits. f. Physik,* **114,** 9–10, *pp.* 620–635, 1939.—An attempt is made to explain the energy transfer in the negative glow from the fast electrons in the cathode-fall space to the electrons of the plasma by collisions between 2 electrons and a gas atom. Born's method is used to calculate the probability of scattering for a collision between an atom and 2 electrons. The assumption that 3-particle collisions consisting of 2 separate collisions facilitate the energy transfer is not confirmed. The problem of the energy balance in the negative glow remains therefore unsolved. L. K.

2207. Theory of the cathodic discharge particles of an arc. W. Weizel, R. Rompe and M. Schön. *Zeits. f. Physik,* **115,** 3–4, *pp.* 179–201, 1940.—The assumption is made that the cathode of an arc does not emit electrons. Three regions are to be distinguished near the cathode: a region of heat conduction in which the current is represented by electrons only, a region of ionization in which the charge carriers are produced, and immediately at the cathode the space-charge region in which the electrons can be neglected. In the case of a Hg high-pressure arc, the potential in the first region is approximately 8 V; in the second region of the order of the ionization potential of the carrier gas. Since these regions have no stability in the direction perpendicular to the arc, the discharge contracts at the cathode. For a contraction to a tenth of the former cross-section, the potential of the space-charge region is 13 V for the Hg high-pressure arc. The discharge near the anode shows analogous regions. L. K.

2208. Metastable atoms in inert-gas discharges. W. Rogowski. *Zeits. f. Physik,* **115,** 5–6, *pp.* 257–295, 1940.—The distribution of metastable atoms in a plane spark gap is calculated with respect to their formation, destruction and diffusion. If Townsend's equations are applied to the mixture of normal and metastable atoms, relations governing the breakdown of the discharge can be derived. An extension of Townsend's theory is given. L. K.

2209. Theory of spark discharge. J. M. Meek. *Phys. Rev.,* **57,** *pp.* 722–728, *April* 15, 1940.—The breakdown of a uniform field is considered to occur by the transition of an electron avalanche from cathode to anode into a self-propagating streamer which develops from anode to cathode to form a conducting filament between the electrodes, the criterion being that a streamer will develop when the radial field about the positive space charge in an electron avalanche attains a value of the order of the external applied field. Photo-electrons in the vicinity will then be drawn into the stem of the avalanche and will give rise to a conducting filament of plasma, and the self-propagating streamer proceeds towards the cathode. The theory dispenses with the classical assumption of ionization by positive ions in the gas or secondary actions at the cathode. An equation for breakdown is developed, and calculated breakdown potentials in air show satisfactory agreement with experiment. Deviations of the theory from Paschen's law are within the limits of experimental error. Classical theory applies as a limiting case for low values of pressure × gap. N. M. B.

2210. Electrical properties of an a.c. high-pressure discharge. J. KERN. *Zeits. f. Physik*, **114**, 9–10, *pp.* 552–563, 1939.—The electrical properties of the Hg high-pressure discharge are greatly influenced by the temperature gradient at the electrodes. There is a strong convection of heat from the arc towards the electrodes, in consequence of which the electronic temperature is higher than the gas temperature. The temperature and with it the ionization decrease rapidly near the electrodes in the discharge at the times when the a.c. passes through zero. The potential, therefore, increases for a short time at every half period. In the arc itself the ionization remains high for vanishing current so that the arc shows the properties of a conductor with variable conductivity. The light emission near the electrodes diminishes greatly in consequence of the drop in temperature when the current vanishes, and dark space is produced at the electrodes. It is shown experimentally that the extension of the dark space decreases with increasing current and electric field [see Abstract 3579 (1937)]. L. K.

***2211. High-pressure Hg discharge lamp.** J. KERN. *Zeits. f. techn. Physik*, **20**, 9, *pp.* 250–257, 1939.—An investigation has been made of the luminous intensity of a Hg high-pressure discharge lamp, at pressures from 2 to 15, and 30 to 130 atm., with power consumptions of 20 to 80 and 250 to 600 W/cm., and with tube diameters of 5 to 15 and 1 to 4 mm. In both regions the luminous intensity was found to be linear with the power consumed per cm. of arc length and indirectly proportional to d^q, where d is the diameter of the tube and q is a constant. At low pressures and wattages the intensity is independent of the pressure while at high pressures and wattages it increases with the pressure. Particular attention is paid to the variation of the output of the lamp in the u.v. region. In these measurements a new water-cooled capillary lamp was used whose construction and operation are described. G. O. B.

2212. Spark-gap discharges of unusual form. U. NEUBERT. *Zeits. f. Physik*, **114**, 11–12, *pp.* 705–708, 1939.—A new form of spark-gap discharge is described which has been produced with an electrostatic generator with spherical electrodes of 25 and 60 cm. dia. It has some similarity to Toepler's positive brush discharge [see Abstract 2547 (1932)] but fills the whole space between the electrodes. L. K.

2213. Mechanism of high-current carbon arc. W. FINKELNBURG. *Zeits. f. Physik*, **114**, 11–12, *pp.* 734–746, 1939.—The characteristic properties of the high-current carbon arcs are caused by the processes at the anode, i.e. the considerable evaporation of the anode (at the rate of 17 mg./sec.), the intense radiation of the anode flame and the anode fall which increases with the current and causes the rising characteristic of the arc [see Abstract 844 (1940)]. The anode flame is interpreted as the glow of the plasma which is produced by evaporation and leaves the anode with a temperature of 8 000 to 10 000°K. From the velocity of flow and the rate of cooling the flame-length is approximately calculated as 2·5 cm., in agreement with experience. The increase of the anode fall with the current is explained by the additional energy needed for the evaporation of the anode and the heating of the plasma. Experiments show that the transport of graphite from the anode to the cathode is not caused by condensation, but is due to particles which are catapulted from the anode perpendicular to its surface. 2/3 of the particles reaching the cathode are charged; the remaining third are neutral. The cathode gains about 40% of the material lost by the anode. L. K.

2214. Control of a Hg high-pressure arc by means of a grid in the plasma. H. Fetz. *Ann. d. Physik,* **37,** 1, *pp.* 1–40, *Jan.,* 1940.—Experimental investigations show that an arc discharge can be controlled and quenched at low pressures by means of net- or sieve-shaped grids. The direct cause of these control effects is the contraction of the discharge cross-section in the grid-holes. In consequence of the contraction a thin double layer is formed in the holes through which all electrons must pass, and the density of charged particles in the anode space is strongly increased. Below a critical pressure the arc is quenched as it becomes unstable; the quenching occurs within 10^{-5} sec. A linear relation exists within wide limits between the control potential and the controlled arc potential in a stabilized arc. The vapour pressure which is necessary to obtain a contraction of the arc at the grid is inversely proportional to the width of the grid-holes. The contracted arc is inclined to oscillations of about 10^5 c./s. L. K.

2215. Variation of sparking potential with initial photo-electric current. J. M. Meek. *Phys. Soc., Proc.,* **52,** *pp.* 547–558, *July,* 1940.—The minimum sparking potential of a discharge gap is known to be lowered appreciably when the cathode of the gap is subjected to the intense u.v. radiations produced by an auxiliary spark gap. This lowering is ascribed to the field distortion produced by the positive space charge formed in the gap as a result of the difference in mobilities of positive ions and electrons, and is explained in terms of the writer's theory of spark discharge. Calculations are made on such a basis for a steady initial photo-electric current and give values for the lowering in reasonable agreement with experiment when it is noted that in all experiments so far performed the source of illumination is a transient one, far shorter in duration than the time to establish the equilibrium space charge calculated. The time lag of sparking for large initial currents is shown to be related to the time of build-up of the space-charge field, and its variation with applied potential and initial current is indicated. Author.

2216. Experiments concerning theory of glow discharge. W. Weizel and W. Olmesdahl. *Zeits. f. Physik,* **114,** 11–12, *pp.* 719–733, 1939.—A part of the negative glow is separated from the main part of the negative glow by a meshed grid which is parallel with the cathode. The anode has the form of a cylinder surrounding the whole discharge. The experiments were carried out in H_2 at a pressure of 1 Tor. The part of the discharge which has been divided off has the potential of the anode, and its properties are independent of the grid potential. If the negative glow is cut off from the anode, it is possible to obtain 2 negative glows which differ in potential and are in some cases connected by a discharge column. The characteristic of a probe has been measured; the results show a satisfactory agreement with theoretical considerations and prove the applicability of the theory for complicated experimental arrangements. [See Abstract 3749 (1939).] L. K.

2217. Theory of negative glow. R. Seeliger. *Zeits. f. Physik,* **115,** 3–4, *pp.* 111–119, 1940.—The theory of the negative glow is discussed with respect to the plasma theory, the applicability of Boltzmann's principle and a simple case which refers to the end of the glow, and the theory of the anode fall. L. K.

2218. Ignition mechanism in long discharge tubes. Part II. Influence of pre-ionization on ignition. W. Bartholomeyczek and E. Wolter. *Ann. d. Physik*, **37**, 2, *pp.* 124–136, *Jan.*, 1940.—The lowering of the ignition potential in a long Ne discharge tube has been measured as a function of the gas pressure (0·1–6 Tor) and auxiliary current [see Abstracts 4818 (1936) and 1256 (1940)]. The relations between the auxiliary current and the pre-discharge were observed until the moment of ignition, and the field distribution before the ignition was measured with probes. The ignition mechanism with auxiliary electrode is different from that without pre-ionization because a pre-current of several orders of magnitude above the ordinary current flows before the ignition, and because the structure of the field before ignition is nearly independent of how the electrodes are earthed. The ignition field becomes more homogeneous if pre-ionization is present. L. K.

2219. Cross-section for change of charge and ionization by high-velocity metallic ions in H_2 and He. C. W. Sherwin. *Phys. Rev.*, **57**, *pp.* 814–821, *May* 1, 1940.—An experimental method is developed in which the primary ionization and change of charge effects of a beam of positive ions can be studied separately. The cross-sections for change of charge and for ionization have been measured for Be^+, B^+, B^{++}, C^+, C^{++}, Al^+, Al^{++}, K^+, Fe^+, Fe^{++}, Fe^{+++}, Cu^+, Cu^{++} and Cu^{+++} ions, moving through H_2 and He with velocities corresponding to accelerating potentials between 6000 and 24000 V. The determination of the cross-section for change of charge was shown to be independent of the size and shape of the collectors used in the measurements, and the effects of scattered incident ions and of secondary electrons from various sources were shown to be negligible. A large energy difference was found between the ions formed in the gas by primary ionization and those formed by the change of charge process, the former having energies of the order of 10 eV and the latter having energies of about 0·1 eV or less. The cross-section values depend upon the type of ion and upon the accelerating voltage and have magnitudes varying from less than 0·01 to 23×10^{-16} cm². for H_2, and from less than 0·01 to 10×10^{-16} cm². for He. Author.

2220. Influence of discharge chamber structure upon initiating mechanism of h.f. discharge. S. Githens, Jr. *Phys. Rev.*, **57**, *pp.* 822–828, *May* 1, 1940.—It is shown that a breakdown in a rarefied gas with e.m.f. of h.f. of the order of Mc./s. may occur through 3 different processes. Mode *a* is characterized by a breakdown voltage of about half the d.c. discharge value. Mode *b* occurs at lower gas densities and is characterized by breakdown at a voltage somewhat above the corresponding d.c. discharge value. Mode *c* is the h.f. counterpart of the Paschen law phenomenon in that, when the density is too low to support an inter-electrode discharge, the latter seeks a longer path. It is shown that all 3 of these modes may operate in the same discharge chamber, sometimes simultaneously, and that the breakdown process may shift from one mode to another with change in pressure or frequency. Many of the baffling complexities in earlier h.f. striking-voltage data may thus be understood. It is pointed out that mode *c* breakdowns are of little value for quantitative interpretation. A type of discharge chamber is described in which the breakdown may be held definitely to modes *a* and *b*. Author.

2221. Ion beam of high definition. M. v. Ardenne. *Zeits. f. techn. Physik*, **20**, 12, *pp.* 344–346, 1939.—To obtain an ion beam of good sharpness a canal-ray stream of small cross-section is first strongly accelerated and, through the velocity spread of the particles, reduced to a few per cent. With the help of a new short-focus electrostatic lens for high potentials the initial cross-section is still further lessened thus producing an ion beam of good sharpness and intensity. Several important applications of such an ion stream are discussed. G. O. B.

2222. Charge exchanges of He canal rays in gases. H. Meyer. *Ann. d. Physik*, **37**, 1, *pp.* 69–75, *Jan.*, 1940.—The ratio between the number of singly and doubly charged Ne particles has been measured for He canal rays of 30-200 ekV. A magnetic field is used to separate the charged He particles after they have traversed a gas chamber. In air and H_2 the number of doubly charged particles decreases rapidly with velocity ; in He, however, this decrease is very small. The charge exchange quotient (ratio of doubly charged to singly charged particles) has been measured as a function of the pressure in the gas chamber. The results permit an estimate to be given of the mean free path of doubly charged He particles. It is found to be 2·3 cm. for He canal rays of 171 ekV in air at 1 mm. Hg pressure for the transition from He^+ to He^{++}. The reverse process has a mean free path of 0·08 cm. under the same conditions. [See Abstract 818 (1938).] L. K.

See also Abstracts **2098, 2101** and

1162B. Discharge figures on photographic plates as dependent on pressure. G. Praetorius.

CONDUCTION IN SOLIDS AND LIQUIDS.

2223. Electrons in metals. W. V. Houston. *Am. Phil. Soc., Proc.*, **81**, 4, *pp.* 525–532, 1939.—The study of the theory of metals is part of the programme for understanding the properties of material bodies in terms of the behaviour of the constituent electrons and atomic nuclei. During the past decade this part of the programme has met with considerable success in its development along two lines. The application of the Pauli exclusion principle and the methods of quantum statistical mechanics has led to an understanding of the absence of a large electronic specific heat. It has made clear how the properties ordinarily associated with free electrons and those associated with electrons bound in atoms can co-exist. The application of quantum mechanical methods to the study of the motion of electrons in the periodic field of the nuclear forces has brought out the explanation of other combinations of these apparently exclusive properties. In particular, the existence of a current at vanishingly small field strengths indicates that at least some of the electrons are esentially free to move. On the other hand, the ponderomotive force on a conductor carrying a current in a magnetic field, together with the smallness of the Hall effect, indicates a very intimate binding of the electrons to the nuclei. This freedom to move under an electric field, combined with the rapid transfer of momentum to the nuclear lattice, is exhibited by the quantum mechanical behaviour of an electron in a periodic field. The states in which an electron has a definite energy can represent a definite average current, and yet the electron momentum will be indeterminate and intimately shared with the lattice. This fact has tended to obscure the position of the conservation of momentum in this theory. Author.

2224. Deviations from Ohm's law at high current densities. E. Guth and J. Mayerhöfer. *Phys. Rev.*, **57**, *pp.* 908–915, *May* 15, 1940.—The deviations from Ohm's law at high current densities are calculated on the basis of the wave-mechanical theory of conductivity. A current density of 10^9 A/cm^2. causes a 1% deviation only. No observable deviations are to be expected at the experimental current densities available at present (10^6 A/cm^2.). This is in agreement with the experiments of Barlow, neither does it contradict those of Bridgman, if the effects found by him are due to secondary factors. The method used consists in the actual solving of the fundamental equation for conductivity in a higher approximation. It is proved that in the Lorentz model (fixed metal ions) the fundamental equation is not soluble in the second approximation in the field strength. A solution in this approximation can be obtained only by assuming inelastic collisions between the electrons and the metal ions. The analogy between the distribution function containing the influence of the electric field and a distribution function found by Pidduck for the motion of ions in gases is pointed out. A generalization of the present theory is indicated by taking into account the influence of the external field on the lattice waves. Authors.

2225. Measurements with high-voltage a.c. resonance circuit. G. Hauser. *Ann. d. Physik*, **37**, 3, *pp.* 249–260, *Feb.*, 1940.—A description is given of a circuit producing 5 × 10^5 V with a primary a.c. voltage of 220 V [see Abstract 1306 (1936)]. The damping resistance of the circuit, the dielectric losses in the condensers and coils and the hysteresis losses in the coils, have been measured, and the factors which limit the obtainable high voltage are discussed. L. K.

2226. D.c. resistance of ceramics. H. Rögener. *Zeits. f. Elektrochem.*, **46**, *pp.* 25–27, *Jan.*, 1940.—The object of this investigation is to produce data on the electrical conductivity of insulators in a temperature range of 400–1 100°C. The substances investigated were Al_2O_3, BeO, ZrO_2, ThO_2 and spinell. The resistance was found by direct measurement of current and voltage; the apparatus used is described in detail. The specimen of insulator was a cylinder about 1 cm. long and of cross-sectional area about 0·8 cm^2. Good electrical connection was made to its ends by platinizing them. Great differences in the conductivity of different specimens were found; this is related to the degree of impurity of the specimen. In the case of BeO and Al_2O_3 a dependence of the conductivity on the previous history of the specimen is found. The final results for the materials are shown in graphical form. G. G.

2227. Fundamentals of metallic contact. R. Holm. *Zeits. f. techn. Physik*, **20**, 12, *pp.* 332–335, 1939.—In considering the conditions of wear between metallic electrical contacts, the author shows the difference between cases in which an arc occurs and those in which it does not occur. In the first case a kind of evaporation of the metal takes place; in the second craters and high spots are formed. Oxidation of surfaces is also a source of trouble. Suitable choice of the contact metals can be of assistance. G. O. B.

2228. Superconductivity and magnetic exchange interaction. H. Welker. *Zeits. f. Physik*, **114**, 9–10, *pp.* 525–551, 1939.—Two new hypotheses are introduced into the electronic theory of metals in order to explain the phenomenon of superconductivity: (1) The concept of the free electron gas is replaced by that of an "electron liquid" which is defined by the consideration that the electrons keep at an average distance from each other, given by the electronic density, in consequence of the Coulomb repulsion. (2) In addition to the classical magnetic interaction a magnetic exchange interaction is introduced which causes a velocity superstructure in the quasi-lattice of the electrons. It is shown that the magnetic exchange interaction alone is not sufficient to explain the superconductive state, but the existence of a superstructure of the electron liquid demands complete diamagnetism in the metal for a magnetic field below a certain threshold value. In the presence of a magnetic field strong Larmor currents represent a state of unperturbed superstructure and therefore the state with lowest energy. Superconductivity is a metastable state. [See Abstract 797 (1939).] L. K.

2229. Electrical resistance of In and In alloys. S. VALENTINER. *Zeits. f. Physik*, **115**, 1–2, *pp.* 11–16, 1940.—The specific resistance of In, In-Pb and In-Sn alloys has been determined at room temperature and the temperature of liquid air. The results confirm the assumption that the two systems do not form an unbroken sequence of mixed crystals. L. K.

2230. Irreversible changes of electrical resistance and reflecting power of condensed films of Sb, As, Te, Fe and Ag. R. SUHRMANN AND W. BERNDT. *Zeits. f. Physik*, **115**, 1–2, *pp.* 17–46, 1940.—Transparent films of Sb, As, Te, Fe and Ag are condensed in high vacuum at 80°K. and afterwards heated to temperatures at and above room temperature. The electrical resistance decreases suddenly and irreversibly with increasing temperature and the reflecting power increases at the same point. Below this point the electrical resistance shows a negative temperature coefficient. The drop occurs at 270°K. for Sb, 298°K. for Te, 650°K. for As, 150°K. for Fe. It is assumed that the substances are in a state near to hexagonal packing below these temperatures and change over to their crystal structure at the temperature of the drop in the resistance. Fe and Ag show the same phenomenon only for extremely thin films. L. K.

***2231. Au-Cr alloys for resistance standards.** A. SCHULZE. *Phys. Zeits.*, **41**, *pp.* 121–126, *March* 15, 1940.—The specific resistance of Au-Cr alloy containing 2·05% of Cr amounts to 0·33 Ω mm^2./m. at room temperature and the thermo-e.m.f. to 7-8 μV/°C. The temperature coefficient of the resistance which is normally 110 parts in 10^6 can be made to disappear by suitable heat treatment of the alloy. The resistance/temperature curves which have been measured between — 200 and + 200°C., are S-shaped. During a course of 3 years the resistance of Au-Cr standards changed by 2 parts in 10^5. Enamelled wires show a slight variation of resistance with atmospheric humidity. It is concluded that this Au-Cr alloy is a suitable material for resistance standards. [See Abstracts 4657 (1937), 2978 (1938) and 2983 (1939).] L. K.

See also Abstracts 2098, 2137, 2277 and

1179B. Critical resistance of moving-coil galvanometers. S. Gerszonowicz.
1181B. Sensitive registering current- and voltmeter for 50-10 000 c./s. H. F. Grave.

DIELECTRICS AND CAPACITANCE.

2232. Determination of dipole moments by molecular-ray method. H. SCHEFFERS. *Phys. Zeits.*, **41**, *pp* 89–97, *March* 1, 1940.—If nonexcited molecules pass through an inhomogeneous electric field, their deviation and the change of their energy are proportional to the field strength or to the square of the field according to whether their dipole moment has a component in the direction of the rotational axis or perpendicular to it. The linear and quadratic effects are theoretically treated; in the first case, part of the molecules show no deviation while the remaining molecules are shifted to both sides symmetrically. The quadratic effect furnishes only symmetric deviations to both sides. The discrepancy between Estermann and Fraser's determination of the dipole moment of HCl and the measurements of the dielectric constant is discussed. It is due to the effect of the molecules in the rotationless state. If they are taken into account, the discrepancy is eliminated. L. K.

2233. Linear effect of electric field for molecular-ray experiment with NH_3. H. SCHEFFERS. *Phys. Zeits.*, **41**, *pp.* 98–105, *March* 1, 1940.—An apparatus is described for measuring the intensity of the molecular rays of NH_3. [See Abstract 2102 (1929).] The deviations of the rays in the electric field are proportional to the field (linear effect). A considerable part of the molecules show no deviation, while the rest are displaced symmetrically to both sides of the original beam, in accordance with the theoretical treatment of the symmetrical top in the electric field. The measurement of the absolute value of the dipole moment of NH_3 results, however, in a value 3 times smaller than that obtained from measurements of the dielectric constant. The possible causes of this discrepancy which lie outside the actual experiment are discussed. L. K.

***2234. Determination of electric moments of molecules.** M. E. HOBBS, J. W. JACOKES AND P. M. GROSS. *Rev. Sci. Instruments*, **11**, *pp.* 126–133, *April*, 1940.—The dipole moment of gases is determined from precise measurements of the dielectric constant and temperature over a small temperature interval. A gas condenser is described consisting of a number of concentric cylindrical electrodes. It is rigidly constructed so as to be free from pressure effects, and has a high value of capacitance and a negligibly small temperature coefficient. The temperature of the gas itself is measured by a Pt resistance thermometer. E. R.

2235. Dielectric polarization in solution. Part I. Failure of the Clausius-Mossotti equation. W. H. RODEBUSH AND C. R. EDDY. *J. Chem. Phys.*, **8**, *pp.* 424–428, *May*, 1940.—It has been assumed by recent writers, including Onsager, that the Debye-Clausius-Mossotti procedure would give satisfactory results for the polarization of a non-associated polar solute in dilute solution in a non-polar solvent. A consideration of the existing data for solutions of this type shows that this classic procedure must lead to erroneous and very misleading conclusions in regard to the polarization of the solute. The Onsager equation on the other hand gives excellent agreement with the experimental data and it is possible to calculate the moment in the vapour state by it from the data in dilute solutions with results rather more satisfactory than those obtained by Böttcher from the dielectric constant of the pure liquid. For certain cases when the Clausius-Mossotti equation appears to hold the agreement is believed to be fortuitous. AUTHORS.

See also Abstracts 1987, 1996, 2189, 2225 and
1164B. Steatite. M. Oyama, Y. Nakazi and F. Nakagawa.

ELECTROCHEMISTRY.

***2236. HgO as active material of positive electrode in alkaline storage cell.** K. KINOSHITA. *Chem. Soc. Japan, Bull.*, **15**, *pp.* 82–88, *March*, 1940.—HgO (both red and yellow) can be used in the electrode plate of the alkaline accumulator in the pasted form by mixing with Ag_2O. Its discharge characteristic curve varies in 2 stages, the first stage being caused by the discharge of Ag_2O with a terminal voltage of about 0·95 V and the second stage being caused by HgO. HgO exhibits rather poor electrical conductivity but this is improved by mixing it with Ag_2O. AUTHOR.

***2237. CoO as active material of negative electrode in alkaline storage cell.** K. KINOSHITA. *Chem. Soc. Japan, Bull.*, **15**, *pp.* 148–153, *April*, 1940.—CoO can be made into the negative electrode plate of the alkaline storage cell in the pasted form, in the same way as other metallic oxides [see preceding Abstract]. The present paper describes the results of the experiments dealing with CoO. AUTHOR.

2238. Electrolytic precipitation of soft γ-Mn. E. HERRMANN. *Ann. d. Physik*, **37**, 2, *pp.* 155–161, *Jan.*, 1940.—The conditions under which soft γ-Mn is electrolytically precipitated have been investigated following Brunke's experiments [see Abstract 554 (1934)]. Foils of soft γ-Mn 0·4 mm. thick can be obtained if the following prescription if used: electrolyte at anode-saturated solution of NH_4Cl; electrolyte at cathode—fresh solution of $MnCl_2$ and NH_4Cl; anode—Pt-foils in clay cylinders wrapped in cellophane; cathode—Al-electrode of polished Al. The temperature should be kept at 30°C., the pH-value at 7 and the current density at 0·2 A/cm². A wiper was moved over the surface of the cathode about 100 times per min., and the electrolytic bath was continually stirred. L. K.

2239. Dissociation constant of hydrazoic acid. M. QUINTIN. *Comptes Rendus*, **210**, *pp.* 625–627, *April* 29, 1940.—The solutions, 0·88–0·915-*M*, used were of 99·7% purity, and were prepared by the interaction of H_2SO_4 and NaN_3 and preserved in darkness. Titration was effected electrometrically with addition of varying amounts of KCl. Concordant results gave $2{\cdot}8 \times 10^{-5}$ as the dissociation constant of HN_3. C. A. S.

2240. Variation of transference numbers of KCl in aqueous solution with temperature. R. W. ALLGOOD, D. J. LE ROY AND A. R. GORDON. *J. Chem. Phys.*, **8**, *pp.* 418–422, *May*, 1940.—The transference numbers of KCl in aqueous solution have been determined for concentrations from 0·01 N to 0·10 N at temperatures from 15°C. to 45°C. by the moving boundary method. Both cation and anion boundaries were used. The results obtained by the two methods are in satisfactory agreement, the sum $(t_+ + t_-)$ for a solution being unity within a few units in the fourth decimal place; the data reported here are also in close agreement with those reported by Longsworth for 25°C. For the whole range of temperature the Longsworth function $t_+^{\circ\prime}$ is linear in the concentration. It is found, however, that the cation transference number decreases with rising temperature, in contradiction to the Kohlrausch generalization which predicts that transference numbers less than one-half should increase with rising temperature. AUTHORS.

2241. Mutual polarity of Ag and Ni in KI solution. E. TOPORESCU. *Comptes Rendus*, **210**, *pp.* 602–603, *April* 22, 1940.—If a plate of Ag is left in contact with a concentrated solution of KI, the Ag slowly dissolves as AgI, and the pH of the solution changes, the effects being proportional to time. Metallic Ag slowly displaces K from KI, and the K reacts with H_2O present, giving an alkaline solution, at the same time playing the part of an electrode. The elevation of e.m.f. of Ag-Pt in KI solution and the inversion of the mutual polarity of Ag and Ni in KI are due to the fact that the couples K-Pt, and K-Ni are the effective electrodes. [See Abstracts 3372 (1938) and 1356 (1939).] A. J. M.

See also Abstract
1155B. Theory of lead accumulator. H. Bécot.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

2242. Classical theory of spinning particles. H. J. Bhabha. *Indian Acad. Sci., Proc., A,* **11,** *pp.* 247–267, *April,* 1940.—The exact relativistic classical equations taking radiation reaction into account for the rotation and translation of a point dipole are given for the case where the dipole is always a pure magnetic dipole in the rest system. These equations are entirely free from any singularities. It is shown that the mass M, angular momentum of the spin I and magnetic moment g_2, are 3 entirely independent constants with no connection between them. The cross-section for the scattering of light by a dipole is given by a classical formula which shows that, due to radiation reaction, the scattering actually decreases as ω^{-2} for very high frequencies ω, instead of increasing as ω^2 when radiation reaction is neglected. The quantum mechanical formula for the scattering of neutral mesons by neutrons is shown to go wrong at energies $h\,\omega > 3\,\mu$ due to neglect of the effects of radiation damping. The classical formula can still be correctly applied in the range $3\,\mu < h\,\omega < M$, where the quantum formula is wrong, M being the neutron mass. Finally, reasons are given for thinking that the quantum theory of the electron fails at energies above about $\sqrt{3 \times 137\,m}$ due to neglect of the effect of radiation damping on the spin, and the quantum theory of the meson and its inter-action with the electromagnetic field at $\sqrt{6 \times 137\,\mu}$. [See Abstracts 3779 (1939) and 537 (1940) and following Abstract.] Author.

2243. Elementary heavy particles with any integral charge. H. J. Bhabha. *Indian Acad. Sci., Proc., A,* **11,** *pp.* 347–368, *April,* 1940.—The previous paper [see preceding Abstract] having shown that all divergences and large cross-sections for neutral mesons are due entirely to neglect of radiation reaction, an attempt is made in this paper to remove those difficulties in the theory of charged mesons which do not occur in the theory of neutral mesons by following up an idea put forward tentatively by the author some time ago on the ground that it would diminish the excessive scattering of charged mesons. It is assumed that the heavy elementary particles can exist in states of all integral charge, positive, negative or zero, the different states having different rest masses, of which the states with charge 0 and e (neutron and proton) must be assumed to have the lowest rest masses, while the proton states of charge $-e$ and $2\,e$ are assumed to have the next lowest. The cross-sections for the creation and annihilation of protons of charge $2\,e$ and $-e$ by several processes are calculated. The collision of a fast proton with another stationary proton is the most effective process for creating protons of charge $2\,e$, the cross-section being of the order 10^{-27} cm^2. The colliding proton must have a kinetic energy of at least 35 eMV. Neutrons of the same energy would produce protons of charge $-e$ on colliding with neutrons. The cross-sections for the production of protons of charge $2\,e$ and $-e$ by mesons or photons are of the order 10^{-27} cm^2. The life time for spontaneous decay of these particles is of the order of $\frac{1}{6}$ seconds, while the life time in air for reconversion into ordinary protons or neutrons by collision with a nucleus is of the order Z 10^{-7} sec. for low velocities. These particles have an interaction with the proton or neutron which is the same as the proton-neutron interaction with small additional terms. The energy-range relationship is calculated. The mean ionization along a track of a proton of charge $2e$ is nearly twice that of a proton or half that of an α-particle of the same range. If the theory is correct these particles are expected to occur in the nuclear explosions produced by cosmic rays, though less frequently than ordinary protons. Study of Wilson-chamber photographs and photographs of nuclear explosions in the emulsions of photographic plates, especially at high altitudes, might be expected to reveal or disprove the existence of these particles. AUTHOR.

2244. Equations of motion of electrons. T. LEWIS. *Phil. Mag.*, **29**, *pp.* 495–507, *May*, 1940.—A theoretical investigation is given of the behaviour of electrons, treated as structureless points, in one another's presence, without introducing concepts foreign to classical electromagnetism, such as those used by Dirac and Pryce. The field is assumed to depend only on the electrons present and to be calculable when the relativistic world lines of the electrons are prescribed. It is also assumed that retarded potentials only are effective. By considering 2 electrons, one with a mass very much larger than that of the other, a Lorentz system can be found in which the electron with the large mass is comparatively at rest, so that its retarded and advanced potentials are practically equal and constant with regard to the time co-ordinate. This system leads to the equations of motion of the other electron. In this final result the damping terms due to radiation are absent. Objections to the theory based on this fact among others are discussed. G. O. B.

2245. Thermionic measurement of e/m. F. M. GAGER. *Am. J. Phys.*, **8**, *pp.* 126–129, *April*, 1940.—A simple thermionic method is described for determining with reasonable accuracy the value of e/m for electrons. The current to a cylindrical anode is measured and the 3/2 power law is used to derive the value of e/m. The end correction is eliminated by making only the central part of the cathode active. W. E. D.

***2246. Experiments with velocitys pectrometer for slow neutrons.** G. E. F. FERTEL, D. F. GIBBS, P. B. MOON, G. P. THOMSON AND C. E. WYNN-WILLIAMS. *Roy. Soc., Proc. A*, **175**, *pp.* 316–331, *June* 12, 1940.—A velocity spectroscope for slow neutrons has been constructed upon the principle of measuring the times of transit of individual neutrons from an intermittent source to a distant ionization chamber. Measurements have been made of the velocity distribution of the slow neutrons from a paraffin wax howitzer at room temperature. By the interposition of absorbers the absorption coefficients of B and Cd have been measured for neutrons of different velocities. The results for B are inconsistent with the law of inverse velocity. AUTHORS.

2247. Temperature factor in electron diffraction. M. PASISHNIK. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp.* 3–16, 1939. *In Ukrainian.*—Experiments are described on the effect of temperature on the distribution of intensity in Debye-Scherrer electron diffraction. The results agree with Pisarenko's theory and with results on the temperature factor for X-rays. [See Abstract 1076 (1930).] D. S.

2248. Kossel-Möllenstedt's electronic interference phenomena and the lattice theory. M. v. LAUE. *Ann. d. Physik*, **37**, 2, *pp.* 169–172, *Jan.*, 1940.—It is shown that the interference fringe systems observed by Kossel and Möllenstedt can be explained with the help of the geometrical lattice theory. L. K.

2249. Cross-section for elastic collisions between neutrons and protons. E. Amaldi, D. Bocciarelli and G. C. Trabacchi. *Ricerca Scientifica*, **11**, *pp.* 121–127, *March*, 1940.—The elastic cross-section σ for collisions of C + D-neutrons of about 0·4 eMV with protons is determined by means of absorption measurements of a particularly well canalized beam in paraffin. The value of $8\cdot7 \times 10^{-24}$ cm². is found for σ. σ is also measured for the slow resonance neutrons of Rh, and found to be 13×10^{-22} cm. The set of 2 values for σ at different energies is in fair agreement with the theory of Bethe and Peierls. L. E. F.

2250. Anomalous scattering of neutrons by helium and the D-D neutron spectrum. E. Hudspeth and H. Dunlap. *Phys. Rev.*, **57,** *pp.* 971–975, *June* 1, 1940.—An investigation of the variation of the ratio of the scattering cross-section of neutrons by He and H_2 has been made. Neutrons were obtained from a *d–d* source partly surrounded by 3 cm. of paraffin. The anomalously high cross-section in He at 1·0 eMV was found, and the He-H_2 cross-section ratio diminishes to about half this maximum value at 1·4 eMV. No other maxima were observed. The *d–d* neutron spectrum was also investigated by He recoils. The spectrum appears to be homogeneous ; no evidence was found for a low energy group of neutrons with an intensity as great as 1% of the main group. This indicates that He^3 is not formed in an excited state. Authors.

2251. Interference phenomena in scattering of slow neutrons. H. G. Beyer and M. D. Whitaker. *Phys. Rev.*, **57,** *pp.* 976–981, *June* 1, 1940. —Transmission measurements of the neutrons absorbed by Cd (C neutrons) are described which show that the total cross-sections for various elements are dependent to a marked degree upon the physical and chemical state of these elements. This is shown by (1) the transparency of single crystals as compared with the same material in a polycrystalline form, and (2) the non-additivity of the cross-sections for chemical compounds and alloys. The de Broglie wavelength of the C neutrons is such that the above effects can be interpreted in terms of interference. The nature of the results is well illustrated by the SiO_2 measurements. The cross-section of the molecule computed from measurements on the component elements is 10·5. The cross-section for the molecule in sand is $8\cdot8 \pm 1$, in fused quartz $8\cdot1 \pm 1$, and in single crystals of quartz $4\cdot3 \pm 0\cdot6$, all in units of 10^{-24} cm². Authors.

2252. Scattering of D-D neutrons. W. D. Allen and C. Hurst. *Phys. Soc., Proc.*, **52,** *pp.* 501–510, *July*, 1940.—The scattering cross-sections for the combined processes of absorption and inelastic scattering of D-D neutrons have been measured in 24 elements. P, in which the 170-min. period of ^{31}Si was induced, was used to detect the neutrons, which had an energy of 3·25 eMV. The results obtained corroborate the conclusions of Kikuchi and Aoki ; the cross-section does not increase monotonically with atomic number, but rather shows a periodic dependence on atomic number. Using P as detector (threshold excitation energy about 2 eMV), it was not possible to observe elastic scattering of D-D neutrons. Authors.

2253. Dependence of secondary emission on primary current. N. Morgulis. *Mém. Phys. Ukrainian S.S.R.*, **8,** 1, *pp.* 83–89, 1939. *In Ukrainian.*—The author discusses the influence of the internal resistance of the emitter on its secondary emission and concludes that the latter should depend also on the primary electron current. Preliminary experimental results are described with various emitters which support this conclusion. D. S.

2254. Improved resolving power of the annular magnetic field method. H. Voges and G. Ruthemann. *Zeits. f. Physik*, **114**, 11–12, *pp*. 709–718, 1939.—The method of an annular magnetic field has the disadvantage of furnishing an asymmetric and diffuse image of the electron source. If the magnetic field decreases radially towards the inner and outer side, the focusing of the electronic beam is improved. The magnetic field is produced by means of 2 concentric coils; 2 Cu strips in the middle of the coils, through which a current flows, ensure the desired radial drop in the field. This arrangement raises the resolving power by a factor of 3 for a given intensity in the focus. L. K.

2255. Electron-optical cylindrical lens action of edge field of condenser. R. Herzog. *Phys. Zeits.*, **41**, *pp*. 18–26, *Jan*. 1, 1940.—In calculating the deflection of an electron beam by a plane condenser field it is usual to assume the actual field of the condenser to be uniform between the plates and zero outside. The author investigates mathematically what error results from making this assumption. It is found that the deflection can be calculated with high accuracy by assuming the uniform field to extend over a slightly different length from the length of the plates and it is shown how to derive the length of this uniform substitute field. For extreme accuracy one must take into account an additional cylindrical lens action of the edge fields but in most practical cases the focal length is so large that this effect can be neglected. J. E. K.

2256. Gauss's dioptric of an electromagnetic cylinder lens. J. Gratsiatos. *Zeits. f. Physik*, **115**, 1–2, *pp*. 61–68, 1940.—An electromagnetic cylinder lens is represented by an electromagnetic field which is 2-dimensional and symmetric with respect to a symmetry plane. Equations are derived for the electron beams which pass near the symmetry plane of the field and form a small angle with the symmetry axis of the force lines. The relations governing the image formation of these beams are deduced. L. K.

***2257. Universal electron microscope.** M. v. Ardenne. *Zeits. f. Physik*, **115**, 5–6, *pp*. 339–368, 1940.—A detailed description is given of a new electron microscope which can be used with magnetic or electrostatic lenses. The objective system can be separated by air locks from the vacuum of the rest of the instrument. For a magnetic objective and illuminated field a resolving power of 30 Å has been reached, and particles of only 10 Å diameter are recognizable. For dark-field observations, which can be obtained by the adjustment of a screen, the resolving power amounts to 50 Å at least. Stereoscopic pictures are obtained by tilting the plane of the object. A system of optical auxiliary microscopes and fluorescent screens allows the visual adjustment of the object and the screens. Schumann plates are used in the photographic camera which furnishes pictures of the size 30 by 45 mm. L. K.

***2258. Electron microscope.** H. Mahl. *Zeits. f. techn. Physik*, **20**, 11, *pp*. 316–317, 1939.—A description is given of a purely electrostatic electron miscroscope which uses 2 electrostatic lenses in such a way that division of the applied potential is avoided. The capabilities of the instrument are shown by several figures. The limit of resolution of the instrument is less than 15 mμ. G. O. B.

*2259. **Resolving power of the magnetic electron lens used as a β-ray spectrometer.** V. E. Cosslett. *Phys. Soc., Proc.*, **52**, *pp.* 511–517, *July*, 1940.—Expressions are obtained for the resolving power of a magnetic electron lens as determined by the geometry of the experimental arrangement in which it is used as a β-ray spectrometer. This calculated distribution is then compared with the focused spread of electron velocities observed in practice, a cloud chamber being used as recording device. The fact emerges that the influence of spherical aberration in the lens is small for the apertures here employed. The results indicate how a high resolving power may be attained in this method. Author.

See also Abstracts 1984, 2024, 2089, 2110, 2127, 2139 and
1194B. Output of cathode-ray oscillographs. B. v. Borries and E. Ruska.
1196B. Image errors in a rotation-free magnetic lens. H. Becker and A. Wallraff.

ELECTROSTATICS.

See Abstract
1183B. Electrometer triode and its applications. H. van Suchtelen.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

2260. Anisotropy of electrical resistance of Na in magnetic field. E. Justi and J. Kramer. *Phys. Zeits.*, **41**, *pp.* 105–106, *March* 1, 1940.—The change of electric resistance of a Na crystal in a transverse magnetic field has been measured as a function of the orientation of the crystal. The resistance is found to be anisotropic. At 20·4°K. the relative increase in the resistance has a minimum value of 9% and a maximum value of 22%. The anisotropy had disappeared for 78°K. [See Abstract 5382 (1936).] L. K.

2261. Magneto-resistance of In. A. Foroud, E. Justi and J. Kramer. *Phys. Zeits.*, **41**, *pp.* 113–121, *March* 15, 1940.—The electrical resistance of very pure In has been measured for low temperatures and in a variable magnetic field. The temperature could be varied from 4·22°K. to 373°K.; the maximum field attained amounted to 40 000 gauss. Without magnetic field the electrical resistance decreases with T^3 below 55°K. in analogy with Al. In a transverse magnetic field the relative increase in resistance seems to reach a saturation point of 1·3, similarly to Al. In a longitudinal field the resistance changes by approximately half of the value for the transverse field. These results show that In does not possess a free electron gas. The similarity between Al and In proves that the valency and the crystal lattice are of great importance for metallic conductivity. [See Abstracts 5065 (1933) and 3816 (1936).] L. K.

2262. Galvano- and thermomagnetic phenomena in Fe and Ni. E. H. Butler, Jr. and E. M. Pugh. *Phys. Rev.*, **57**, *pp.* 916–921, *May* 15, 1940.—The 4 transverse galvano- and thermomagnetic effects (Hall, Ettingshausen, Nernst and Righi-Leduc), the Thomson coefficient and the thermal and electrical conductivities, have been measured in bars of Ni and electrolytic Fe. Three independent relations between the effects, derived by Sommerfeld on the basis of the Fermi statistical theory of metallic conduction, are verified within a factor of 3. It is shown further that this theory does not account for the size of an individual effect unless the average field for the conduction electrons in the Fe is twice the measured value of the magnetic induction, and that in Ni some

15 times the measured value. Two possible explanations are suggested. AUTHORS.

See also Abstract 2137.

MAGNETISM AND ELECTROMAGNETISM.

2263. Ferromagnetism of system Mn-Bi. K. THIELMANN. *Ann. d. Physik*, **37**, 1, *pp.* 41–62, *Jan.*, 1940.—It is found that Mn-powder reacts with fused Bi between 272°C. and 600°C. with formation of the magnetic phase. Quantitative determinations of the Bi-content of the magnetic alloy lead to the formula BiMn. The X-ray investigations of a compact metallic piece and of magnetic powders show the same structure as NiAs. An apparatus is described which allows the investigator to obtain the magnetic alloys in a form suitable for magnetic measurements. The hysteresis of BiMn, its saturation moment and its magnetization/temperature curve, have been measured. BiMn possesses a Curie-point at (343 ± 2)°C. The magnetic properties of BiMn are compared with those of the other binary Mn-alloys in which the second partner belongs to the same group in the periodic system as Bi. L. K.

2264. Magnetic study of 2-phase Fe-Ni alloys. A. T. PICKLES AND W. SUCKSMITH. *Roy. Soc., Proc. A*, **175**, *pp.* 331–344, *June* 12, 1940.—Measurements of magnetic saturation intensity of annealed Fe-Ni alloys have been used to demonstrate the existence of a 2-phase field in the iron-rich part of the system. The phase boundaries have been determined at temperatures above 450°C. and the relation of the equilibrium phase diagram to the thermal hysteresis observed under normal rates of temperature change has been studied. AUTHORS.

***2265. Magnetic properties of non-homogeneous systems. Part I. Experimental technique.** L. F. BATES, C. J. W. BAKER AND R. MEAKIN. **Part II. Ni Amalgams. Part III. Ferromagnetic Co and Ni in Hg.** L. F. BATES AND C. J. W. BAKER. *Phys. Soc., Proc.*, **52**, *pp.* 425–451, *July*, 1940.—In Part I a description is given of a new apparatus and technique for the examination of the magnetic susceptibility of a non-homogeneous material with particular reference to the investigation of amalgams of metals in dilute solution in Hg. An important feature of the apparatus is that the electromagnet has one pole tip with a cylindrical surface and one pole tip with a plane face, so that, when an amalgam is placed in a vertical tube suspended from a torsion balance, each portion of the amalgam is exposed to the same value of the gradient of H^2 in the direction along which motion of the tube is possible; consequently, measurements can be made with amalgams which separate on standing. In Part II the above apparatus is used to measure the magnetic susceptibilities of a series of Ni amalgams containing 0·01 to 2·68% Ni by weight over the temperature range 15° to 300°C. All freshly prepared amalgams which have not previously been heated are diamagnetic, the Ni exhibiting a paramagnetic mass-susceptibility which is approximately independent of temperature. When an amalgam is heated to 225°C. it becomes ferromagnetic, and the ferromagnetism persists when the amalgam is cooled. The results are explained in terms of some new views on the ferromagnetism of Ni recently put forward by Néel. In Part III the ferromagnetic properties of small quantities of Co and of Ni dissolved in Hg were measured by the Gouy method, using a container which was evacuated by a simple method previously described. Co behaved as if it had a specific magnetization of 190 instead of 163·9 and Ni with 45·5 instead of 57·6 c.g.s. units per gm. The experimental results are discussed in the light of a theory, due to Jaanus, of the magnetic behaviour of small quantities of dissolved ferromagnetics. AUTHORS.

2266. Electromagnetic induction in water. H. D. EINHORN. *Roy. Soc. S. Africa, Trans.*, **28**, 2, *pp*. 143–160, 1940.—The e.m.f. induced in water flowing through a magnetic field is investigated, the voltage being measured by means of a valve voltmeter. It is proportional to the speed, the magnetic induction, and the length of conducting paths, exactly as in metallic conductors. Though reduced by an internal voltage drop due to circulating currents, the measurable voltage is still proportional to the speed and independent of the conductivity; an electromagnetic method of measuring flow speeds is thus possible. An application to the oscillographic investigation of hydraulic transient phenomena, such as water hammer, valve actions, etc., is suggested. AUTHOR.

***2267. Theory of a single-layer, bifilar, absolute standard of mutual inductance.** C. SNOW. *Bureau of Standards, J. of Research*, **24**, *pp*. 597–638, *June*, 1940.—A formula is derived for the mutual inductance of 2 helical wires wound bifilarly upon the same cylindrical form. This aims at a precision sufficient for use in absolute electrical measurements, so that terms are retained which, compared with the principal term, are relatively small quantities of the order of the square of the ratio of pitch to cylindrical radius. Nominally the 2 helical windings consist of wires of equal diameters, equally spaced, with equal cylindrical radii, but allowance is made for the case where these 3 equalities are not quite attained. The axial lengths are assumed to be equal, so that, since their pitch must be the same, the total number of turns is the same. The latter is considered to be integral, which permits of the 2 return currents being carried each by a straight wire parallel to a generator of the cylindrical form and close to it. The effect of these lead wires is included in the formula. The azimuth angle between these generators is assumed to lie between $-\pi$ and π, so that the point of current entrance for the primary is on a turn adjacent to that of the secondary. Allowance is made for a general type of current distribution. AUTHOR.

2268. Reversible processes in magnetic materials with small internal strain. W. DÖRING. *Zeits. f. Physik*, **114**, 9–10, *pp*. 579–601, 1939.—The relations between the ΔE-effect (difference between the modulus of elasticity in the demagnetized state and the state of magnetic saturation), the reversible permeability and remanence and the susceptibility and stress, have been investigated for magnetic materials for which the crystal energy is much greater than the internal strain. The formulae are derived without any special assumptions on the distribution of the internal strain, with the exception that it is on the average isotropic. The calculations have been carried out in detail for the case that the space diagonal is the direction of spontaneous magnetization, as in Ni, but the results for other cases are given as well. L. K.

***2269. Compensation coil for measurements with the magnetometer.** W. STEINHAUS AND A. KUSSMANN. *Phys. Zeits.*, **41**, *pp*. 53–55, *Feb*. 15, 1940.—A coil is described for measurements with the magnetometer which compensates the field of the coil containing the substances under investigation. In this arrangement the compensation coil lies on the same side of the magnetometer needle as the field coil, and the two coils of equal magnetic moment but of opposite sign are rigidly connected. L. K.

See also Abstracts 1980, 2002, 2026, 2035, 2145 and 1177B. Substitution of a single rule for the two 3-finger rules. I. Herrmann.

MEDICAL RADIOLOGY AND ELECTROLOGY.

2270. Tissue differentiation in radiography. D. R. Gould. *Radiography,* **6,** *pp.* 83–92, *May,* 1940.—A discussion of 3 factors upon which the radiographic differentiation of the body tissues is primarily dependent: (1) The overall density; intensity of radiation is not directly proportional to the kV^2 or to the current but depends on the wave form or the degree of rectification; again, the emulsion shows a wavelength dependency; (2) the degree of contrast between shadows; this depends on the density and thickness of tissues; contrast is increased by the use of intensifying screens, since fluorescence is a surface phenomena, but the range of densities is reduced; maximum contrast cannot be obtained if the time of development is less than that which is standard for the particular emulsion and developer; (3) detail of shadow outlines; reference is made to the use of immobilization devices, control of scattered radiation by the use of stationary or moving grids, size of focal spot and the asymmetrical distribution of the radiation from a line focus tube. T. A. C.

2271. Emission and transmission of X- and γ-radiation. G. W. C. Kaye and W. Binks. *Brit. J. of Radiology,* **13,** *pp.* 193–212, *June,* 1940. —A survey of published data on the ratio of X-ray emission shows that the output of a tube in röntgens is predictable under standard conditions of operation. The paper next deals with a method of calculating the X-ray absorption of materials based on Kramer's law of X-ray emission and a graphical solution, utilizing theoretical data for the components of the absorption coefficients of narrow beams of X-rays. The derived transmission curves for different exciting voltages are illustrated by the case of lead filtration, particularly in its relation to X-ray protection problems. A similar procedure is followed in the case of a narrow beam of γ-rays from Ra B + C, utilizing published data for the energy distribution and absorption coefficients of the rays. By corresponding means the Pb equivalents of various materials can be calculated, and it is stated that experimental observations with 50 to 400-kV X-rays are in satisfactory agreement with such computed curves and appear to justify the calculations for higher voltages. G. E. B.

2272. Radium protection. Measurements of exposure to γ-rays. R. E. Fricke and M. M. D. Williams. *Radiology,* **34,** *pp.* 560–566; *Disc.,* 566–567, *May,* 1940.—After pointing out the difficulties of defining biologically a tolerance dosage rate for radiation, and mentioning some of the uncertainties of blood counts, the authors accept the value given by the Committee on Protection, of 0·1 r. per day, and proceed to measure doses obtained in practice by means of photographic films. They show that softer radiation produces relatively more blackening than hard radiation and stress the fact that, for many reasons, blackenings should be compared with those produced under known conditions. The authors conclude that for the measurement of weak stray radiation the photographic method has about the same accuracy as small condenser ionization chambers. G. E. B.

2273. Doubling of virus molecules. T. Neugebauer. *Zeits. f. Physik,* **114,** 11–12, *pp.* 667–668, 1939.—It is shown that contact between only a few atoms of a virus molecule and a protein molecule is sufficient to furnish the energy necessary for the changes in the molecular structure of the protein. L. K.

2274. Theory of biological probability and mutations. N. Koyenuma. *Zeits. f. Physik,* **114,** 11–12, *pp.* 669–671, 1939.—The author uses Glocker's theory of probability [see Abstract 792 (1933)] in connection with Dehlinger and Sommermeyer's formulae for the mutation probability [see Abstract 1845 (1939)] to derive an expression which represents the probability of mutation as a function of the energy of state, the temperature and the number of the molecules in the chromosome. It is concluded that absorbed radiation energy is important for spontaneous mutation. L. K.

2275. Action of radiations on bacteriophages. F. Holweck, S. Luria and E. Wollman. *Comptes Rendus,* **210,** *pp.* 639–642, *April* 29, 1940.—A study of the effects of (*a*) monochromatic X-rays of 17 kV (M_0 Kα rays) and (*b*) heterogenous X-rays 200 kV constant p.d. unfiltered from a W target, and (*c*) α-particles from Rn + active deposit on the bacteriophage C_{16} effective on the dysenteric bacilli Y_{6R} of which the diameter is 50-70mμ. The principal results are summarized: (1) The proportion of active particles diminishes exponentially with the dose D of the radiation, i.e. $N/N_0 = e^{-\sigma D}$. (2) The action of the radiation is a function of the $D = It$ and not of the intensity I or of the duration of the irradiation t taken separately. (3) Equal doses of 17 and 200 kV X-rays have the same action when the dosage is expressed in r units ($I\ r = 2 \times 10^9$ ions/cm^3.) produced in air. The action is a function of the energy absorbed by the unit of volume and is independent of the wavelength of the radiation. (4) In the case of the α-particles the dose, measured in ions/cm^3., which it is necessary to employ to obtain the same action, is approximately 7 times more than for X-rays. The significance of this is discussed in the light of the more densely ionizing track of the α-particle and the "target volume" in which an ion must be produced within the bacteriophage to be effective. A graph is shown with the survival plotted against the dose in $r\ x\ 10^{-5}$ and α-particles/mm^2. $\times$ 10^{-7}. If the doses are expressed in ions/mm^3. then σ represents the "target volume". This volume has a diameter of 28 mμ in the case of X-rays and 15 mμ in the case of the α-particles. The results are in accord with the conception that bacteriophages, as in the case with certain viruses, behave as macro-molecules and the inactivation corresponds to a "quantized" transition of such a molecule. [See also Abstract 3033 (1938).] T. A. C.

See also Abstract 2170.

OSCILLATIONS AND WAVES.

2276. Intensity problems of ultra-short electric waves. H. Klumb. *Zeits. f. Physik,* **115,** 5–6, *pp.* 321–325, 1940.—The author makes an attempt to ascertain the intensities of short electric waves as function of the wavelength in the region 1 cm.–0·01 cm. and compares the existing data, showing that the observations as well as the laws of radiation lead to the assumption of a region between electric waves and atomic radiation in which electromagnetic energy can only be produced in small intensity with the hitherto known oscillators. L. K.

***2277. Dry rectifiers in electrical measurement practice.** H. F. Grave. *Zeits. f. Instrumentenk.,* **60,** *pp.* 74–87, *March,* 1940.—Amongst the various kinds of dry rectifiers the 2 best known, the copper-oxide and the selenium rectifier, have in their behaviour no fundamental difference. An account is given of dry rectifiers, their methods of use and their peculiarities, including the influence of temperature and the dependence on frequency. Details are given of the modern rectifier instrument. J. J. S.

2278. Electromagnetic wave propagation in a cone-shaped horn. H. Buchholz. *Ann. d. Physik*, **37**, 3, *pp*. 173–225, *Feb.*, 1940.—The author investigates the propagation of electromagnetic waves from a radiative source which is arranged inside an infinitely long, hollow cone whose mantle is a perfect conductor. Only those radiators have been taken into consideration which produce axially symmetric waves, i.e. electric or magnetic transverse waves. The propagation of these waves is treated mathematically; electric and magnetic waves are separately dealt with. The two types of waves do not differ qualitatively. A detailed account is given of the properties of the waves (amplitude, phase velocity, impedance, etc.) inside the horn. L. K.

2279. Velocity of propagation of radio waves over the ground. F. T. Farmer and H. B. Mohanty. *Phys. Soc., Proc.*, **52**, *pp*. 456–463, *July*, 1940.—A technique is described for the measurement of the rate of travel of h.f. impulses over the ground. Two transmitters 60 km. apart and operated off a common a.c. supply provided the signals, and the time intervals between the arrival of the local and distant impulses were measured at each station. From these the mean rate of travel could be determined. The measurements were made on a cathode-ray tube in a manner similar to that used in ionospheric work, and the precautions necessary to secure accurate results are described. Results are given which show that the velocity of propagation is within a few per cent of that of light; and it is concluded that the experiments of other workers which yielded a much smaller value for the velocity are subject to some error. Authors.

***2280. Ionospheric apparatus.** I. Ranzi. *Ricerca Scientifica*, **11**, *pp*. 133–138, *March*, 1940.—In continuation of previous work [Abstracts 570 and 571 (1940)] this paper describes new apparatus set up in the National Institute of Geophysics in Rome. The available frequency range of the apparatus is from 5·5 to 10 Mc./sec. The receiver is of the superheterodyne type and the recording is carried out by means of a cathode-ray oscillograph. Diagrams of the transmitter and of the receiver are given as well as photographs of the complete apparatus. G. G.

2281. Ionosphere measurements at Shanghai. P. Lejay. *Comptes Rendus*, **210**, *pp*. 381–385, *March* 11, 1940.—Measurements have been made of the coefficient of reflection from the E- and F-layers of short-pulse transmissions on a wavelength of 115 m. The measurements were carried out at the observatory of Li-Ka-Wei in the first half of 1939, using as aerial a rectangle of height $\lambda/4$ and length $\lambda/2$, the base being the ground and the 2 vertical arms being connected to earth through resistances. Measurements of the field strengths of the echoes compared with the theoretical maximum deduced from the transmission measurements gave the reflection coefficients. Coefficients of the order of 0·8 have been obtained, but the occurrence of high reflection coefficients did not necessarily involve the presence of numerous multiple echoes. On the other hand, numerous multiple echoes were sometimes found when the reflection coefficient did not exceed 0·2. A. W.

2282. Normal and abnormal region-E ionization. E. V. Appleton and R. Naismith. *Phys. Soc., Proc.*, **52**, *pp*. 402–415, *May*, 1940.—An account is given of the variation of normal and abnormal region-E ionization through the sunspot cycle. While the solar u.v. light responsible for the production of normal region E varies markedly through the cycle, it is found that such radiation may not be expressed as a single-valued function of mean sunspot numbers, the solar radiation being greater for a given sunspot number during the years of rising solar activity than during years when the activity is falling. Normal and abnormal region-E ion productions have not been found to vary similarly during years of varying solar activity. AUTHORS.

2283. Origin of radio fade-outs and absorption coefficient of gases for light of wavelength 1 215·7 Å. W. M. PRESTON. *Phys. Rev.*, **57,** *pp.* 887–894, *May* 15, 1940.—It has been suggested that the ionization in the D region which causes radio fade-outs is caused by radiation of the first line of the Lyman series of H, at 1 215·7 Å, from solar eruptions. The actual absorption coefficients for this line, previously only roughly known, have been measured with the following results: O_2 0·28, $N_2 < 0{\cdot}005$, CO_2 2·01, water vapour 390 (all values reduced to N.T.P.). Although it can probably penetrate to sufficiently low altitudes, it appears unlikely that this line can produce ionization and hence cause fade-outs. The possibility is considered that these may be due to higher Lyman series members, or to X-rays of around 2 Å wavelength. AUTHOR.

2284. Application of ionospheric data to radio communication problems. Part I. E. V. APPLETON AND W. J. G. BEYNON. *Phys. Soc., Proc.*, **52,** *pp.* 518–533, *July*, 1940.—The reflection of waves obliquely incident on the ionosphere is studied theoretically. A direct method of calculating the maximum usable frequency reflected at oblique incidence by a thick " parabolic " layer, for both short-distance (plane earth) and long-distance (curved earth) tranmission, is developed, and the results exhibited graphically. In an *Appendix* it is shown how the thickness of a " parabolic " layer may be deduced from the results of vertical-incidence ionospheric sounding. AUTHORS.

***2285. Recorder for electrical potentials. Damping of piezo-electric systems.** F. OFFNER. *J. of Applied Physics*, **11,** *pp.* 347–352, *May*, 1940.—A piezo-electric ink-writing oscillograph has been found useful in the recording of bio-electric potentials. The analysis of the electromechanical system of the instrument is simplified by deriving the equivalent electrical network. From this the phase-frequency, amplitude-frequency and transient characteristics can be calculated. While these are all improved by inserting a series resistor, critical damping cannot be achieved by this means alone in a piezo-electric device because the necessary coefficient of coupling, greater than 0·943, is unobtainable in a crystal. Critical damping and best frequency response are not necessarily equivalent. The best test of fidelity is comparison of records with the wave form of the applied potential. Such comparisons have been made with the instrument described. AUTHOR.

See also Abstracts

1292B.	H.F. behaviour of space charge rotating in magnetic field. J. P. Blewett and S. Ramo.
1293B.	Absorption of radio waves by thin water shell. K. Morita.
1306B.	Magnetostriction oscillators. D. C. Stenning.

PHOTO-ELECTRICITY.

2286. Hallwachs photo-electric effect at high temperatures. R. DEAGLIO. *Accad. Sci. Torino, Atti*, **75,** *Disp.* 1a, *pp.* 164–166, *Nov.–Dec.*, 1939.—Confirmation is obtained of the existence of a photo-electric effect in the saturation current region of incandescent metals. Further work indicates that the photo-electric effect is important in the region controlled by the space charge as well as in the saturation region. F. C. C.

2287. Photosensitivity of Cu_2O electrodes. E. Miseliuk. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp*. 17–26, 1939. *In Ukrainian.*—It is shown experimentally that the sensitivity of Cu_2O surfaces to the Becquerel effect is conditioned by a thin layer formed when the electrode is cooled in water during manufacture. This supports the view that the Becquerel effect is a blocking-layer effect. D. S.

PIEZO-ELECTRICITY.

See Abstracts 1987, 2215, 2285.

THERMIONICS.

2288. Work function of irregularly emitting cathodes. B. Gysae and S. Wagener. *Zeits. f. Physik*, **115**, 5–6, *pp*. 296–308, 1940.—The surfaces of cathodes covered with foreign metals or oxides show an irregular emission. Consequently, only mean values can be given for the work function of these cathodes which differ for different ways of averageing. The determination of the temperature coefficient of the work function from Richardson's relation and from the photo-electric emission furnish a mean value which is important for the emission current while the method of the shift of the characteristics furnishes a different value, the " arithmetic " mean value. The problem of the temperature coefficient of the work function cannot yet be unambiguously decided for cathodes with irregularly emitting surfaces. L. K.

2289. Zone model of oxide cathodes. Y. Uehara and M. Takahasi. *Chem. Soc. Japan, Bull.*, **15**, *pp*. 15–21, *Jan.*, 1940.—As metallic atoms are formed in the oxide crystals the zone model for oxides is based on the " impurity semi-conductor " model of Wilson. The thermionic emission equation for this model is derived but the thermionic work function deduced does not equal the photo-electric work function. The emission from oxides cannot thus be directly caused by the impurity atoms of metal formed in the oxide. Allowance for a 2-dimensional metal layer on the surface gives the Richardson equation and the thermionic and photo-electric work functions coincide. The theory explains the existence of an optimum emission from a solid solution of BaO and SrO at a particular composition. A mechanism for the fluorescence of alkaline-earth oxides is also proposed. J. B. W.

2290. Neutralization and ionization of Cs and K on thoriated W surfaces. N. Morgulis and M. Bernadiner. *Mém. Phys. Ukrainian S.S.R.*, **8**, 1, *pp*. 35–53, 1939. *In Ukrainian.*—Experiments on the neutralization of Cs and K ions at a W surface covered to various degrees with active Th, provide further evidence for the heterogeneity of structure of Th on W. Experiments on ionization of Cs and K atoms at the thoriated W surface are also described, the results being similar to those previously found for Na atoms [see Abstract 3837 (1939)]. D. S.

2291. Surface structure of thoriated W examined by ionic microscope. N. Morgulis. *Mém. Phys. Ukrainian S.S.R.*, **8**, 2, *pp*. 149–153, 1940. *In Ukrainian.*—The heterogeneous structures of Th films of various thicknesses on W was confirmed by an " ionic microscope " using Cs ions produced thermally at the cathode surface under investigation. D. S.

See also Abstracts 2221, 2245.